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PROCEEDINGS OF CONFERENCE IN THE MATTER OF POLLUTION OF THE INTERSTATE WATERS OF THE RED RIVER OF THE NORTH, NORTH DAKOTA-MINNESOTA

Department of Health, Education and Welfare
Washington, D. C.

14 September 1965

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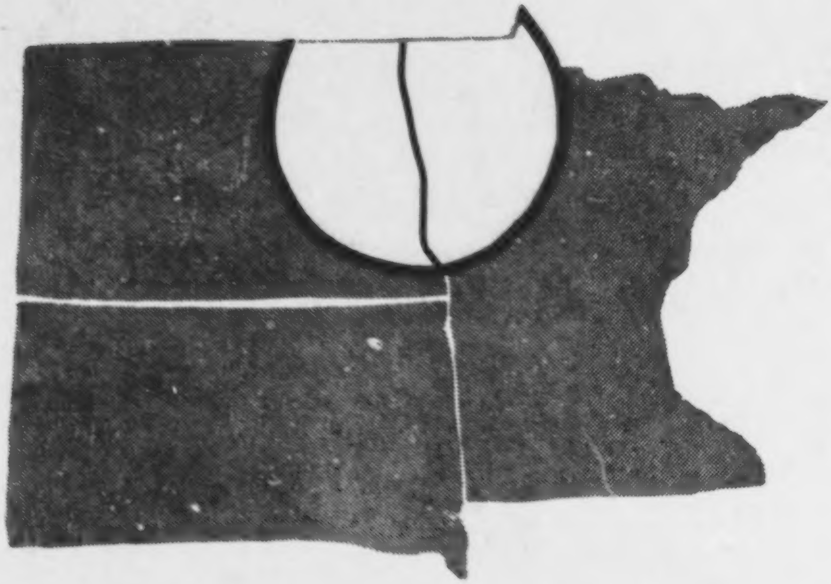

Conference

In the Matter of Pollution of the Interstate Waters of the Red River of the North North Dakota - Minnesota

September 14, 1965

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ERRATA SHEET

Proceedings, Conference in the Matter of Pollution
of the Interstate Waters of the Red River of the North
September 14, 1965

Page 206, Table 1-B - Red River of the North, September 1964 should be Table 1-B - Red River of the North, November 1964.

Page 207, Table 1-B (Cont.) - Red River of the North, September 1964 should be Table 1-B (Cont.) - Red River of the North, November 1964.

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SUMMARY OF CONFERENCE

POLLUTION OF THE INTERSTATE WATERS
OF THE
RED RIVER OF THE NORTH AND ITS TRIBUTARIES

(Minnesota-North Dakota)

On the basis of reports, surveys, or studies, the Secretary of Health, Education, and Welfare, having reason to believe that interstate pollution of the Red River of the North and its tributaries, caused by discharges of untreated and inadequately treated sewage and industrial wastes in Minnesota and North Dakota, was endangering health and welfare in both States, called a Conference in the matter of pollution of the aforesaid interstate waters. The first session of the Conference was held on September 14, 1965, in Fargo, North Dakota. The Conferees, their staffs and other interested parties also met in Minneapolis, Minnesota, on January 18, 1966, and March 4, 1966.* This is a summary of Conference discussions at these three sessions.

The following Conferees, representing the State water pollution control agencies of Minnesota and North Dakota, and the U. S. Department of Health, Education, and Welfare, participated in the Conference on September 14:

Lyle H. Smith	Minnesota Water Pollution Control Commission Minneapolis, Minnesota
Russel G. Schwandt	Minnesota Water Pollution Control Commission Minneapolis, Minnesota
George C. Scott	Minnesota Water Pollution Control Commission Minneapolis, Minnesota
Willis Van Heuvelen	North Dakota State Department of Health Bismarck, North Dakota
Norman L. Peterson	North Dakota State Department of Health Bismarck, North Dakota
Gordon K. Gray	North Dakota Water Conservation Commission Valley City, North Dakota

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*Due to severe weather conditions, North Dakota was not represented at the March 4, 1966 session. However, this summary was discussed with a North Dakota conferee by telephone on March 4, 1966.

Herbert C. Clare	U. S. Department of Health, Education, and Welfare Kansas City, Missouri
Murray Stein, Chairman	U. S. Department of Health, Education, and Welfare Washington, D. C.

The following also participated in the first session of the Conference:

Mr. Hayse H. Black	U. S. Department of Health, Education, and Welfare Cincinnati, Ohio
Honorable A. J. Christopher	Mayor Pembina, North Dakota
Mr. H. R. Cowles	Otter Tail Power Company Fergus Falls, Minnesota
Mr. Evan D. Dildine	U. S. Department of Health, Education, and Welfare Kansas City, Missouri
Mr. Harlan M. Erskine	U. S. Department of the Interior Bismarck, North Dakota
Mr. A. E. Forsman	Water & Sewage Department Grand Forks, North Dakota
Mr. Thomas P. Gallagher	U. S. Department of Health, Education, and Welfare Cincinnati, Ohio
Mr. Edwin E. Geldreich	U. S. Department of Health, Education, and Welfare Cincinnati, Ohio
Mr. Phil Q. Gibbs	U. S. Department of the Interior Billings, Montana
Lt. Col. Leslie B. Harding	U. S. Army Corps of Engineers St. Paul, Minnesota
Mr. David R. Hedrich	U. S. Department of Agriculture Milwaukee, Wisconsin
Honorable Herschel Lashkowitz	Mayor Fargo, North Dakota

Honorable H. R. Magnuson	Mayor Grand Forks, North Dakota
Mrs. G. E. Mann	League of Women Voters Fergus Falls, Minnesota
Mr. Ernest Martin	The Pillsbury Company Grand Forks, North Dakota
Mr. J. L. Porterfield	American Crystal Sugar Company Denver, Colorado
Honorable Karl Rolvaag	Governor State of Minnesota
Mr. Kenneth Ruby	Water & Sewage Utilities Superintendent Fargo, North Dakota
Mr. A. D. Sidio	U. S. Department of Health, Education, and Welfare Cincinnati, Ohio
Mr. Nels Snustad	U. S. Department of Agriculture Fergus Falls, Minnesota
Mr. Howard J. Sowden	Public Utilities Superintendent Fergus Falls, Minnesota
Honorable R. M. Stordahl	Mayor Moorhead, Minnesota
Mr. Russell W. Stuart	State Game & Fish Department Bismarck, North Dakota
Mr. Art Thoraldson	County Water Board Grand Forks, North Dakota
Mr. Myron F. Tiemens	U. S. Army Corps of Engineers St. Paul, Minnesota
Mr. Donald A. Townley	U. S. Department of Health, Education, and Welfare Kansas City, Missouri
Mr. Donald Vogtman	U. S. Department of the Interior Minneapolis, Minnesota
Mr. Frank L. Woodward	State Department of Health Minneapolis, Minnesota

The Chairman of the Conference pointed out that:

1. Under the Federal Water Pollution Control Act (33 U.S.C. 466 et seq.) pollution of interstate waters which endangers the health or welfare of persons in a State other than that in which the discharges originate is subject to abatement under procedures described in the Act.

2. The first step of this procedure is the calling of a Conference.

3. The purpose of the Conference is to bring together representatives of the States and the U. S. Department of Health, Education, and Welfare, to review the existing situation and the progress which has been made, to lay a basis for future action by all parties concerned, and to give the States, localities, and industries an opportunity to take any remedial action under State and local law which may be indicated.

The Conferees adopted the following conclusions and recommendations, unanimously except as otherwise indicated:

1. The Red River of the North from Wahpeton-Breckenridge to the International Boundary is an interstate stream within the meaning of the Federal Water Pollution Control Act.

2. Municipal and industrial waste discharges from Minnesota and North Dakota reaching the Red River of the North are creating interstate pollution. This pollution creates health hazards and deleteriously affects municipal water supply, fish and other aquatic life, and recreation in both States.

3. Cognizance is taken of the active programs of Minnesota and North Dakota in controlling water pollution. The Federal Conferee indicated that delays in controlling water pollution in the Red River of the North have been caused by the extreme technical difficulties in dealing with the fluctuation of waste loads and stream flow in the Red River of the North, and the rapid population growth of the region. The State Conferees consider that municipalities and industries in the Red River Valley have made notable progress in the control of water pollution during the past ten years. They believe that there has been no appreciable delay in the correction of any serious water pollution control problems during that period.

4. Since nutrients discharged in the sewage and industrial wastes from Fargo and Moorhead cause excessive biological growths downstream, the maximum practical reduction of nutrients, including phosphorus, in these wastes is to be accomplished as soon as possible.

5. Maximum permissible effluent concentrations from Fargo and Moorhead are to be equal; based on current flow (4 MGD from Fargo and 2 MGD from Moorhead), they are not to exceed 36 mg/l five-day BOD. Permissible effluent concentrations are to be reviewed periodically in relation to increased or decreased waste flow and adjusted when necessary. Under present conditions of river flow the ultimate BOD

discharged in the Fargo-Moorhead area shall not exceed 2,800 pounds per day.

6. At the request of the Conferees, a further bacteriological survey was made by staff of the Federal Water Pollution Control Administration to determine whether additional measures were required to protect the bacteriological quality of the Red River of the North. (A report on this survey is included as Appendix V of the conference transcript.) On the basis of this survey, the Minnesota and Federal Conferees recommend that no domestic or industrial waste discharge contain total coliform densities in excess of 5,000/100 ml. The North Dakota Conferees recommend that no domestic or industrial waste discharge cause total coliform densities in the River to exceed 5,000/100 ml. after proper mixing.

7. All municipal sewage discharged to the Red River of the North and its tributaries in the Conference area is to be connected to and treated in the municipal waste treatment facilities, or separate adequate treatment provided.

8. No industry in the Conference area is to discharge process wastes under ice cover.

9. Wastes from the American Crystal Sugar Company plant at Moorhead, Minnesota, are to be discharged during the spring run-off period not in excess of the limits contained in Chart A, attached. It is anticipated that facilities for complete storage of wastes during the sugar beet campaign will be necessary.

10. Wastes from the American Crystal Sugar Company plant at Crookston, Minnesota, are to be discharged not in excess of the limits contained in Chart B, attached. It is anticipated that facilities for complete storage of wastes during the sugar beet campaign will be necessary.

11. Wastes from the potato plants at Grand Forks, North Dakota, now discharging to the Red River of the North are to be collected and sent to the municipal waste treatment system following in-plant treatment to remove solids, or equivalent treatment provided.

12. If, as a result of wastes discharged from the American Crystal Sugar Company plant at East Grand Forks, Minnesota, slime growths develop or significant benthal oxygen demand or other adverse effects occur, reduction of these wastes will be required.

13. Required remedial action is to be accomplished in accordance with the following schedule:

    (a) All municipalities in the Conference area are to have adequate treatment facilities completed and in operation by April 1, 1968.

(b) Necessary industrial waste reduction is to be accomplished by April 1, 1968. The North Dakota State Department of Health or the Minnesota Water Pollution Control Commission may grant to specific industries an extension of the deadline for one year, until April 1, 1969, where extensive construction is necessary.

(c) The Minnesota and Federal Conferees recommend that the North Dakota State Department of Health or the Minnesota Water Pollution Control Commission may allow five years, until April 1, 1971, to accomplish removal of nutrients, including phosphorus, from waste discharges where delays in development of effective removal processes indicate that the time is needed. The North Dakota Conferees recommend that five years may be allowed to accomplish removal of nutrients, including phosphorus, from waste discharges if by that time a feasible method of nutrient removal has been developed.

Attachments 2

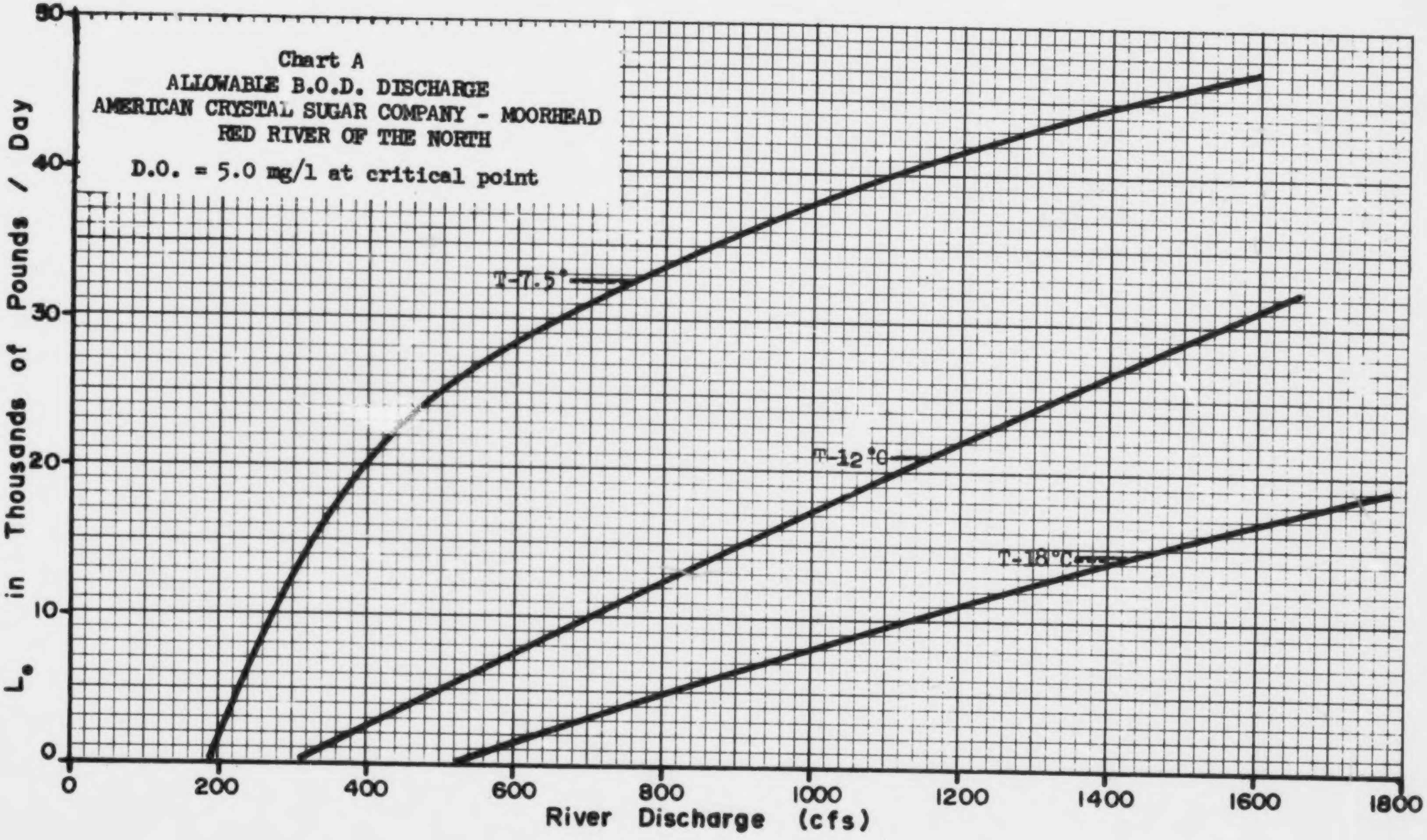


Chart A
ALLOWABLE B.O.D. DISCHARGE
AMERICAN CRYSTAL SUGAR COMPANY - MOORHEAD
RED RIVER OF THE NORTH

D.O. = 5.0 mg/1 at critical point

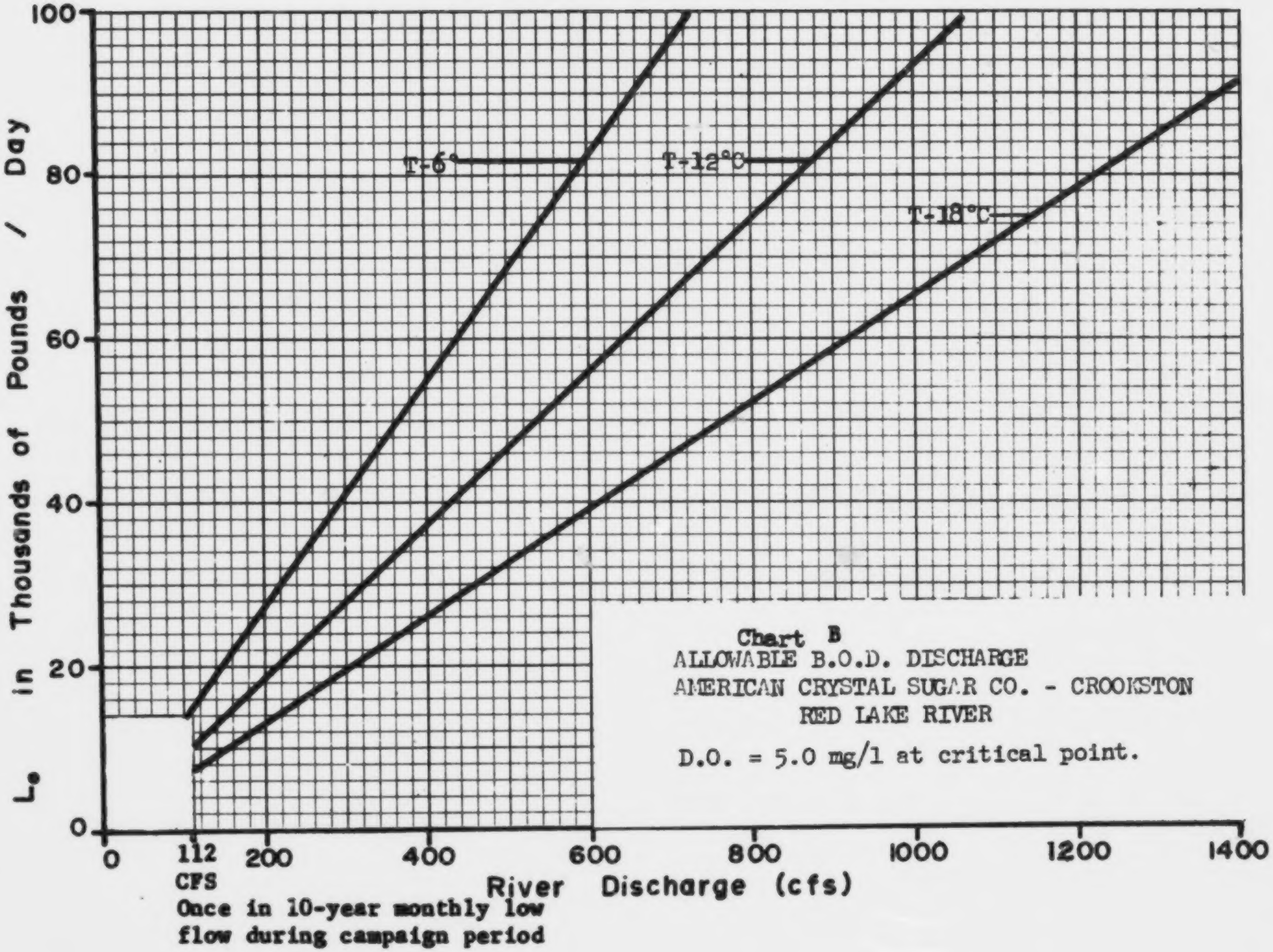


Chart B
ALLOWABLE B.O.D. DISCHARGE
AMERICAN CRYSTAL SUGAR CO. - CROOKSTON
RED LAKE RIVER

D.O. = 5.0 mg/1 at critical point.

CONFERENCE

in the matter of

Pollution of the Interstate Waters of the

RED RIVER OF THE NORTH

A Conference in the Matter of Pollution of the Interstate Waters of the Red River of the North convened at 9:30 o'clock a. m. on Tuesday, September 14, 1965, in the Civic Auditorium, Fargo, North Dakota.

PRESIDING:

Murray Stein, Chief, Enforcement Branch, Division of Water Supply and Pollution Control, U. S. Department of Health, Education, and Welfare, Public Health Service, Washington, D. C.

CONFEREES:

Herbert C. Clare, Regional Program Director, Division of Water Supply and Pollution Control, Public Health Service, Kansas City, Missouri.

Willis Van Heuvelen, Chief, Environmental Health & Engineering Services, North Dakota State Department of Health, Bismarck, North Dakota.

Norman L. Peterson, Division of Water Supply & Pollution Control, North Dakota Department of Health, Bismarck, North Dakota.

Gordon K. Gray, Commissioner, North Dakota Water Conservation Commission, and Chairman, Red River Valley Planning Committee, Valley City, North Dakota.

George C. Scott, Vice Chairman, Minnesota Water Pollution Control Commission, Minneapolis, Minnesota.

Lyle H. Smith, Executive Engineer, Minnesota Water Pollution Control Commission, Minneapolis, Minnesota.

Russel G. Schwandt, Member, Minnesota Water Pollution Control Commission, Minneapolis, Minnesota.

PARTICIPANTS:

Mr. Hayse H. Black	U.S. Department of Health, Education, and Welfare, Cincinnati, Ohio
Honorable A. J. Christopher	Mayor, Pembina, North Dakota
Mr. H. R. Cowles	Otter Tail Power Company, Fergus Falls, Minnesota
Mr. Evan D. Dildine	U.S. Department of Health, Education, and Welfare, Kansas City, Missouri
Mr. Harlan M. Erskine	U.S. Department of the Interior, Bismarck, North Dakota
Mr. A. E. Forsman	Water and Sewage Department, Grand Forks, North Dakota
Mr. Thomas P. Gallagher	U.S. Department of Health, Education, and Welfare, Cincinnati, Ohio
Mr. Edwin E. Geldreich	U.S. Department of Health, Education, and Welfare, Cincinnati, Ohio
Mr. Phil Q. Gibbs	U.S. Department of the Interior, Billings, Montana
Lt. Col. Leslie B. Harding	U.S. Army Corps of Engineers, St. Paul, Minnesota
Mr. David R. Hedrich	U.S. Department of Agriculture, Milwaukee, Wisconsin
Honorable Herschel Lashkowitz	Mayor, Fargo, North Dakota
Honorable H. R. Magnuson	Mayor, Grand Forks, North Dakota
Mrs. G. E. Mann	League of Women Foters, Fergus Falls, Minnesota
Mr. Ernest Martin	The Pillsbury Company, Grand Forks, North Dakota
Mr. J. L. Porterfield	American Crystal Sugar Company, Denver, Colorado
Mr. Kenneth Ruby	Water & Sewage Utilities Superintendent, Fargo, North Dakota

Mr. A.D. Sidio	U.S. Department of Health, Education, and Welfare, Cincinnati, Ohio
Mr. Nels Snustad	U.S. Department of Agriculture, Fergus Falls, Minnesota
Mr. Howard J. Sowden	Public Utilities Superintendent, Fergus Falls, Minnesota
Honorable R. M. Stordahl	Mayor, Moorhead, Minnesota
Mr. Russell W. Stuart	State Game and Fish Department, Bismarck, North Dakota
Mr. Art Thoraldson	County Water Board, Grand Forks, North Dakota
Mr. Myron F. Tiemens	U.S. Army Corps of Engineers, St. Paul, Minnesota
Mr. Donald A. Townley	U.S. Department of Health, Education, and Welfare, Kansas City, Missouri
Mr. Donald Vogtman	U.S. Department of the Interior, Minneapolis, Minnesota
Mr. Frank L. Woodward	State Department of Health, Minneapolis, Minnesota

CHAIRMAN STEIN: May we get started, please.

We heard the announcement on the radio today, you have your first storm of the season. I guess we brought it. This is not unusual. We generally do that.

And for myself, this is indeed an achievement, because last night as I crossed the river here, I arrived in my fiftieth state, so for me this is indeed a landmark, going to all states of the Union, and it is really a little odd that North Dakota should be the last one.

The Conference is open.

This Conference in the matter of pollution of interstate waters of the Red River of the North and its tributaries from its origin to the Canadian border, involving the states of Minnesota and North Dakota, and the Department of Health, Education, and Welfare, is being held under the provisions of Section 9 of the Federal Water Pollution Control Act. The Secretary of Health, Education, and Welfare is required to call a Conference of this type when, on the basis of surveys, reports or studies he has reason to believe that pollution of interstate waters subject to abatement under the Federal Act has occurred.

The purpose of the Conference is to bring together the state water pollution control agencies, the representatives of the Department of Health, Education, and Welfare, and other interested parties to review the existing situation, the progress which has been made, and to lay a basis for future action by all parties concerned, and to give the states, localities and industries an opportunity to take any remedial action which may be indicated under state and local law.

The Conference technique is rather an old one. It is used by many state agencies informally in the normal conduct of their business in the field of water pollution control. The concept of the Conference was proposed by the United States Supreme Court as long ago as 1921 in the famous case of New York against New Jersey involving interstate pollution. I would like to quote from this court opinion.

"We cannot withhold the suggestion, inspired by the consideration of this case, that the grave problem of sewage disposal by the large and growing population living on the shores of New York Bay is one more readily to be most wisely solved by cooperative study and by conference and mutual concession on the part of representatives of the states so vitally interested in it than by proceedings in any court however constituted."

We strongly support the conference technique and we measure our success by the situations which are solved at the conference stage rather than by the court actions we bring.

Under Section 8 of the Federal Water Pollution Control Act, the Secretary of Health, Education, and Welfare has notified the official state water pollution control agency of this Conference. These agencies are the Minnesota Water Pollution Control Commission and the North Dakota State Department of Health.

Minnesota will be represented by George C. Scott, Vice Chairman of the Commission, Russel G. Schwandt, Commissioner, Minnesota Department of Agriculture, and Lyle H. Smith, Chief Engineer, Minnesota Water Pollution Control Commission.

North Dakota will be represented by Willis Van Heuvelen, State Sanitary Engineer, Norman Peterson of the North Dakota Department of Health, and Gordon K. Gray, North Dakota Water Conservation Commission.

Mr. Herbert Clare of the Public Health Service, U. S. Department of Health, Education, and Welfare, with headquarters at Kansas City, Missouri, has been designated as conferee for the Federal Government.

And my name is Murray Stein. I am from Washington, D. C., headquarters of the Department of Health, Education, and Welfare and have been designated as Chairman by Secretary of Health, Education, and Welfare John W. Gardner. I am also Secretary Gardner's representative.

The representatives of the official agencies are privileged to bring whomever they wish to the Conference and have them participate in the Conference. However, this is a Conference between the state representatives and the representatives of the Department of Health, Education, and Welfare, and these parties constitute the conferees.

Both the States and the Federal Government have responsibilities in dealing with interstate water pollution control problems. The Federal Water Pollution Control Act declares that the states have primary rights and responsibilities for taking action to abate and control interstate pollution. It has always been the policy of the Department of Health, Education, and Welfare to give full recognition to this traditional role of the states. The function of the

Department is to encourage the states in these activities. In addition, the Department of Health, Education, and Welfare is charged by law with specific responsibilities in connection with interstate pollution control problems.

The Federal Water Pollution Control Act provides that pollution of interstate waters, whether the matter causing or contributing to such pollution is discharged directly into such waters or reaches such waters after discharge into a tributary of such waters, which endangers the health or welfare of persons in a state other than that in which the discharges originate, is subject to abatement. The Conference will, we hope, provide a clear picture of the problem, review the progress that has been made, and identify any remaining problems. By the conclusion of this Conference, we hope to reach agreement on any action which may be indicated to abate any interstate pollution.

All the conferees will be called upon to make statements. The conferees, in addition, may call upon participants whom they have invited to the Conference to make statements. At the conclusion of such statements, the conferees will be given an opportunity to comment or ask questions, and at the conclusion of the conferees' comments or questions I may ask a question or two. This procedure has proven effective in the past in developing a clear statement of the problem and in reaching agreements on equitable solutions.

At the end of all the statements, we will have a discussion among the conferees and try to arrive at a basis of agreement on the facts of the situation. Then we will attempt to summarize the Conference orally, giving the conferees, of course, the right to amend or suggest modifications of the summary.

Under the Federal law, the Secretary is required at the conclusion of the Conference to prepare a summary of it, which will be sent to all the conferees. The summary, according to the law, must include the following:

1. Occurrence of pollution of interstate waters subject to abatement under the Federal Act.

2. Adequacy of measures taken toward abatement of pollution; and

3. Nature of delays, if any, being encountered in abating the pollution.

The Secretary of Health, Education, and Welfare is also required to make recommendations for remedial action if such recommendations are indicated.

Now a word about the procedure governing the transcript of the Conference. A record and verbatim transcript will be made of the Conference by Mrs. Virginia Rankin. Virginia and I have been working together for a long time. She is an independent reporter operating out of Kansas City, and we started working before Virginia was married. I know I am getting to look older, but, Virginia, you look just the same.

Mrs. Rankin is making this transcript report for the purpose of aiding us in preparing a summary, and also providing a complete record of what is said here. We will make copies of the summary and transcript available to the official water pollution control agencies of Minnesota and North Dakota. We have found generally it is best that people should request transcripts through their state agencies, rather than come directly to the Federal Government. The reason for this is that we would prefer the people who are interested in the problem to follow their normal routine in dealing with state agencies rather than the Federal Government on these matters after the Conference has been concluded. This has worked successfully in the past, and we will be most happy to make this material available to the states for distribution.

I would suggest that all the officers, except those at the head table, making statements come to the lectern and identify themselves for the purpose of the record.

Now, I think it is our privilege today to have with us the Governor of one of the states concerned with the Conference. I think we in the Federal Government, and I know people in the neighboring states, and I am sure the people in the home state, realize that Governor Karl Rolvaag has been one of the foremost proponents of clean water. He has an enviable record in this area during his tenure as Governor of Minnesota, and he has had some of the most difficult and vexing problems we have in the field. Today we have possibly one of the problems, but his problems rank all the way from dealing with a complex area such as Minneapolis-St. Paul, where you have a tremendous concentration of population and industry, and dealing with streams that are reasonably clean and trying to preserve them and keep them clean.

I think the Governor has demonstrated the ability to use Federal, State, and local resources to deal with these problems in an equitable manner. As a matter of fact, the study the Federal Government originally took on the Red River of the North was as a result of a request by Governor Rolvaag that we look into this problem. He has made a tremendous contribution to the national program of Federal legislation by giving advice and consultation, and we regard the Governor among all the fifty governors as one of those who is most interested in this problem, who, in spite of all the complicated tasks that a governor is faced with in running a modern State government, has always found time to deal with water pollution control problems, has dealt with these in a completely competent, technical and perceptive manner, and has brought balance and good judgment and wise consultation to all our efforts in the field.

I am sure, in speaking for the Federal Government, that our program of water pollution control in the midwest, particularly in the waters around Minnesota, would never be so far advanced as it is if it hadn't been for the unflagging efforts of Governor Rolvaag. I would like to call on Governor Rolvaag.

Governor. (Applause)

GOVERNOR ROLVAAG: Thank you very much, Murray Stein, for that rather glowing presentation. I hope, Mrs. Rankin, when we get the transcript, that that will not have been stricken from the record. (Laughter)

Mr. Stein and conferees and those interested representing the two great States of North Dakota and Minnesota, the industrial users, the agricultural users and the community users of the waters of our common river, the Red River of the North, Mr. Stein pointed out that I have had an interest in the whole area of water pollution. It is true that I did request of the Federal authorities a thorough examination and a study in depth of the matter, the degree and extent of pollution of the Red River of the North. I made this request to the Department of Health, Education, and Welfare in the section that Mr. Stein heads because of an incident that happened just a few days after I took my oath of office as Governor of the State of Minnesota.

I had had a passing interest, of course, as our citizens do in Minnesota, in the degree of purity of our waters, in the extent of the water's usability for recreational and industrial purposes, but just a few days after I took my oath of office we had a couple of industrial accidents in the vicinity of Minneapolis and St. Paul and on the Minnesota River in the vicinity of Mankato, Minnesota, resulting in a massive spillage of several millions of gallons of both petroleum oils and of soybean oils in the Minnesota and the Mississippi Rivers. This occurred in the spring of the year, partly at the time when ice still covered the rivers. Some precautions were taken, but the full extent of the damages and the effect were not realized until the spring breakup, when the oil and the pollutants began to show up in massive proportions in the river.

Our Minnesota legislature was at that time in session. It also occurred at a time when our water fowl were returning north from their winter sojourn in the southland, and there were millions of gallons of oil that were pouring down the rivers into the stopping places and the resting places of the wild ducks returning north.

It may seem a little odd that an entire state would get aroused over the matter of a few thousand ducks, but, of course, it went much deeper and much further than a few thousand ducks. A few thousand ducks parenthetically are pretty important in these days. I would like to see some Federal authorities as concerned about the duck population as the Department of Health, Education, and Welfare is concerned about the extent of the pollution. If they were as concerned about that as we are about pollution, we might well close our water fowl season for a year or two to get the population back up where it ought to belong.

Our people became aroused and our legislature became interested. We called out the National Guard, mind you, and all our conservation people, the Army Corps of Engineers, the U. S. Coast Guard, the Public Health Service, Mr. Murray Stein and his people, scientists, biologists of all gradations were interested in the problem that faced us at that time. As a result of that experience, we requested a study in depth of the whole question of the pollutants in the rivers of the Minnesota, the St. Croix and the Mississippi. We have had a similar conference to this with the State of Wisconsin, both in Madison and in St. Paul. And along with the interest we also requested a study of this Red River of the North.

The Red River of the North is a peculiar river in American geography. It is a singular river that flows northward. It is not the property of either North Dakota or South Dakota. It is an interstate river, but more than that it is an international river, and our friends to the north, the Canadians, also have a deep and abiding interest in the pollutants and the pollution, the degree and the extent of the usage of the Red River of the North.

The water belongs to no ne person, no one community, no one industry. It can belong to no one purpose. It is used for agricultural purposes and irrigation. It is used for industrial purposes. It is used for community purposes. It is a source of water supply and it should be more than it is at the present time a source of recreational opportunities for an ever-increasing population.

This great valley has an interesting history. It is both a part of the oldest part of North Dakota and Minnesota and it is at the same time part of the youngest part of our joint states. At one time this whole valley was populated by buffalo, by moose, by elk, a thriving fur trade in beaver pelts at one time existed in this area of our State of North American heartland. We will never go back to the time when we will see again herds of buffalo or American bison, of elk or of moose, though we do have within this valley several thousand head of moose and a herd or two of elk. It has been one of the great waterfowl areas of all of North America. It perhaps will never again see the day that it is the nesting areas of the massive flights or massive concentrations of waterfowl that we once knew it.

There are, however, certain basic observations that should be made in regard to water pollution of this river. Minnesota and North Dakota have had meetings, I am told, ever since 1931 in regard to the pollution of the Red River of the North. We in Minnesota passed in 1945 the Water Pollution Control Commission Act, which gave us some authority as a State entity to move into the areas of regulation of water pollution and the control of water pollution. Since that time, through several steps and acts of the legislature we have improved that Act and substantially extended the authority of the Water Pollution Commission. It is at the present time a substantially influential organization or agency of State Government. I think all of us who work in this area would like to see certain improvements made in the law and certainly as the needs arise that legislation will become effective in the future days.

There is, of course, pollution in the Red River here. There is pollution in the Red River all the way from its source to the mouth of the river in Canada. The question before us today or before our study is concluded and determinations are to be made as to how North Dakota, Minnesota and the Federal Government, the United States of America, are to act in joint effort will be an assessment of how little pollution we should permit, how far we should go, what industry can afford, what waters agriculture basically need, and what should be the degree of purity that is needed for all the social and economic efforts that we jointly recognize are a part and parcel of our society.

We want it clearly understood to all those conferees here from North Dakota and from the Department of Health, Education, and Welfare and to all the interested organizations that are here that Minnesota is interested in achieving the highest possible degree of purity of water, taking into consideration all the necessary uses of this great river. I have often said that we have not really applied to certain areas of human endeavor our full and our total scientific knowhow. The day is certainly coming when we are going to have for all practical purposes almost pure water in all our major streams, despite the fact that they may be used for industrial waters, because when our science can put a man on the moon, as our science ought to, then surely our science can also wrestle with the problems of pure water and clean air.

And so my appearance here today is simply one of assuring you, Mr. Stein, and you from North Dakota and our citizens here that Minnesota is interested in and will support the necessary steps to be taken to clean up not only this river, but all the rivers and our lakes and our streams in our common States.

Thank you very much.

CHAIRMAN STEIN: Thank you, Governor.

(Applause)

CHAIRMAN STEIN: Thank you Governor. I want to assure you, too, that the Federal Government is giving this the highest priority, and I know you may not be, but some of the people in this audience are familiar with the technical people we have here, and we indeed have assigned our first team to the problem. Mr. A. D. Sidio is one of our senior stream investigators and we also have with us Mr. Hayse Black, who I think is recognized internationally as the outstanding industrial waste expert, and that is in the world, I don't think there is any question about it. And Mr. Black is right here to help us with the problem.

I think this is one of the advantages of having a Federal effort on this, to be able to get men like this with their resources to bear on the problem.

We also, as I understand, have greetings from Governor Guy. Mr. Van Heuvelen, will you speak for him?

MR. VAN HEUVELEN: Governor Rolvaag and Mr. Stein and friends who are here at this Conference, I bring you regrets from Governor Guy. I know that because of other commitments he is indeed sorry that he cannot attend.

I think his sentiments concerning this Conference are pretty well outlined in a letter that he forwarded to the North Dakota Department of Health, which was written August 31, and if I may, I would like to read this letter into the record. The letter is addressed to the State Department of Health, Bismarck, North Dakota.

"Thank you for your invitation to attend the Pollution Conference concerning the Red River Basin. I think this Conference is very timely and very important. It will undoubtedly illuminate the excellent progress that is being made now in municipal and industrial pollution control. Undoubtedly it will also, however, point to the definite need for constant improvement and constant surveillance of pollution control measures in the Red River Basin. So precious is our water in this State, and, for that matter, in the nation, that we cannot permit the destruction of this valuable national resource through the mishandling of pollution.

"I wish you every success in this Conference. Very truly yours, William L. Guy, Governor of North Dakota."

CHAIRMAN STEIN: Thank you very much, Mr. Van Heuvelen.

Now, you know, among other things, and I guess I don't do this so much any more because of the press of time, but among other things we do have professional meetings throughout the country, and one of the meetings we do have, of course, often involves the mayors of our cities, because where people are that is where sources of pollution are. And through the years, one of the mayors in there has always selected among the various things that mayors can specialize in at these meetings--generally we break up into various groups--water resources and the water pollution problem; that is the Mayor of Fargo has been a participant and, indeed, a significant contributor to national philosophy and thought in water pollution control. I have known and met him and worked with him in various parts of the country through the years. He has always invited me to come up to Fargo, but I never thought I would come here this way.

I don't know whether the people of the area here recognize the contribution that your mayor has made to water resources development and philosophy in this country, but it has been very great indeed, because he is considered one of the municipal experts in the country on the problem.

It gives me great pleasure indeed to call on Mayor Herschel Lashkowitz. Mayor. (Applause.)

MAYOR LASHKOWITZ: Thank you, Murray Stein. Governor Rolvaag and other dignitaries from the State and Federal levels and municipal levels and this distinguished audience.

I want to extend the warmest greetings on behalf of my associates in the City government for having the opportunity of having this wonderful Conference here in our City, and I think it would be remiss on my part if I didn't acknowledge the fact that we are very honored and delighted to have such men as Governor Rolvaag with us this morning, because I do know that without his leadership a Conference such as this would not be possible. I know that he has been extremely influential in alerting the people throughout this area to the grave problem of water pollution, and it is really nothing less than fair and proper that we do acknowledge his splendid leadership in this area of water pollution and water resources development, and I want to publicly thank Governor Rolvaag for having been so instrumental in helping to land this Conference.

I also am pleased to acknowledge Murray Stein, Chairman and Moderator, because I have been privileged to know this gentleman through the years and I do know that it is largely men of this caliber who, because they were concerned with Fargo, North Dakota, have helped us in realizing our present position of water pollution control, because I do know that we could not have accomplished our present outstanding facility without two Public Health Service grants, and I want to thank the administration for their role in this regard and certainly Mr. Stein who is conversant with our problems.

I think it is rather interesting to note that your whole City is one of the few communities throughout this wide area that have a modernized mechanically operated sewage treatment plant that is presently in existence and serving this area, and I think that it would be well for me to acknowledge at this point the fact that the people of Fargo have had the willingness to go ahead with our leadership in cooperating with the State and Federal levels.

It might be interesting to note just going through the records that this sewage plant expansion and additions program has cost a total of $1,490,000, and this has involved an expenditure in two grants from The Public Health Service in excess of $418,000, and the balance of over one million dollars was locally financed. This came out of, if you please, the sewage treatment rates. Now, this has involved only one modest rate increase, and I had better be correct in this, in 30 years or thereabouts, and even though we have had this modest rate increase, I am pleased to note that we have a favorable position in regard to other communities throughout this area ratewise. This in spite of the fact that we have this tremendous capital expansion program.

Now, enough of this. Suffice to state that this has involved planning through the years, and I think a few acknowledgements are in order. We couldn't do this without the cooperation of the State Health Department, of course, Mr. Van Heuvelen, Mr. Peterson and his associates through the years, and I think it is proper to acknowledge the role of such pioneers in water resources control as my friend and former colleague Fred C. Hagen, Water Commissioner, H. H. Behlmer, Mr. Eide, Mr. Pinney, and now our very able Water Superintendent, K. R. Ruby. These gentlemen have worked together and I have been privileged to be associated with them.

But I would like to state in extending a welcome to you that even though we have been privileged to husband these resources, being able to finance this plant expansion and addition program, this is just a beginning in the direction of pollution control, because we must be concerned with what happens upstream and downstream in the Red River and its tributaries if we are to really arrest dangerous pollution. So consequently, we have the attitude that we must be alert to new developments and new contingencies and new potential dangers and help our friends and neighbors upstream and downstream, and this means that we must work together.

And so when I thank Governor Rolvaag, I mean it from the bottom of my heart, because we cannot exist as an island here in pure water, but we must help all of our neighbors, whether they be rural or urban, first to realize their investment in pure water and second to help point the way toward doing something about it.

I think it would be ironic indeed if at this very hour that we are on the threshhold of realizing the beginning of phase 1 of the Garrison Diversion Program, looking towards the eventual movement of water from the waters of the Missouri across the State of North Dakota into the Red River of the North, that we bring this water across the State at tremendous expense and sacrifice and find, lo and behold, that we have more pollution on our hands.

So I think that this is a top priority item, and I think that when we have a gathering such as this present this morning it indicates that the best resources of our nation are willing to help us, and I think one thing that we must stress here is that we cannot do it by ourselves. I want to publicly thank the Federal Government, particularly the Department of Health, Education, and Welfare, for recognizing this problem, for making money available to those who qualify by coming up with their local responsibilities, and I think it is high time that all of us go out to our respective constituents and tell them that we might as well stop baiting the Federal Government and stop baiting the State Government and stop sniping at each other and recognize that if we are to keep our water resources pure and viable and serviceable for this and subsequent generations we are going to have to work together as a team with local, State and Federal Governments each having a prominent and significant role.

Again thank you, Murray Stein, and thank you, Governor Rolvaag, and thank you one and all. We are grateful to you.

CHAIRMAN STEIN: Thank you, Mayor.

(Applause.)

CHAIRMAN STEIN: At this point, let me outline again what I think would be the best procedure. We will call on the Federal Government to present its statement and report and then hear from the states. I think this will be the best way to present this. I know that the Federal Government has made an exhaustive study of the problem.

Before I call on them, I have had a peek at it, as you may have had, and I think that the analyses made here are as definite as I have seen in any report and the recommendations are as definite, outfall by outfall. So whatever the disposition of the conferees is, I think the analyses and the proposals of the Federal report are sophisticated indeed.

With that I would like to call on Mr. Herbert Clare to see if we can start the Federal presentation. Mr. Clare.

MR. CLARE: Thank you, Mr. Chairman. Governor Rolvaag, Mayor and conferees.

As a conferee I would like to say just a few words although there is very little that I can add after the excellent statements by the Governor, the Mayor and Chairman Stein.

As a representative of the Public Health Service in Region VI, in which this basin is located, I want to acknowledge the excellent cooperation and relations that we have had with the State water pollution agencies of North Dakota and Minnesota. As the Governor indicated, the river has been studied many times since 1931. It is often referred to as the most studied river in the United States. I personally believe that the studies were necessary and were actually made as a result of the phenomenal growth and development which has occurred in the basin. If you look back 30 years or more, you can see the excellent progress that has been made, the increased load on the river, the necessity for waste treatment, and so forth.

Governor Rolvaag referred to the interest of our good neighbors to the north. Local people call this the upper part of the basin. Most of us engineers call it the lower part of the basin. But someone said, all rivers are supposed to flow south, so this river flows in the wrong direction.

But the Canadians are concerned about quality of the waters of the Red River of the North and possible effects of the Garrison Diversion. Because of this concern, the Governments of Canada and the United States have referred this problem to the International Joint Commission, and the International Joint Commission has presently in operation an advisory board, which board is initiating a study of water quality in the Red River of the North. We are very fortunate to have had the study in depth to which Mr. Stein and the Governor referred, the study which was requested by Governor Rolvaag, because this will give the International Joint Commission Advisory Board a running start on their appraisal of the problem of pollution of the international waters of the Red River of the North.

The Public Health Service also has some experts here. I should like to introduce two of my associates from the Kansas City Regional Office. These are men that many of you know, they are men that you may want to contact today because of progress and developments in the region. Let me urge you to do this as opportunity affords and as you have problems to take up with them.

I should like to introduce these two engineers, Evan Dildine, Chief of our Construction Grant Section. Is Evan here? And Donald Townley, Chief of our Enforcement Section in Region VI of the Public Health Service.

Now, I don't want to take any more of your time because we do want to get into the reports and statements of the Federal agencies. The study to which reference has been made followed the request by Governor Rolvaag in early 1964. The study was planned jointly by the Public Health Service and the State water pollution control agencies of the States of Minnesota and North Dakota. The study was conducted by the Public Health Service. I do want to acknowledge, however, a great deal of assistance and cooperation on the part of the State water pollution control agencies in North Dakota and Minnesota.

The engineer in charge of the study for the Public Health Service is Mr. A. D. Sidio, from the Public Health Service Sanitary Engineering Center at Cincinnati. So we would at this time like to call on Mr. Sidio to present the report of the study which was made by the Service.

CHAIRMAN STEIN: Thank you, Mr. Clare.

As Mr. Sidio comes up, I would like to say that the repeated study has given us certain advantages. I guess one of the reasons that your river was studied was because of the fortuitous geography. As Mr. Clare points out and several others have alluded to, rivers are supposed to go south, and the river that fascinated everyone by not going south I guess was the Nile, at least when I was a boy they used to confuse us all the time by talking about the east bank and the west bank of the river and when you were dealing with the Nile and the Pyramids you were never sure which side they were on.

I do think that because of this possible fascination and because of its serviceability that the Red River of the North is such a studied river. I do think that we have two rivers in the United States that get that kind of treatment. One was the Potomac. because it was so close to Washington and I guess because it was so bad that we have had so many studies, and the other through the years has been the Red River. I think because of those studies, we are reaping the benefit of these, although this is probably an unearned increment, but nevertheless the increment is there. We have come up with a pretty definite report, the kind of definitive report, I think, which is not always possible in dealing with rivers that haven't received this much study.

So with that I think we should go on. I don't think you should feel abashed, though, about 1931. We just had a recent case where we discovered that a State had an order against a community since 1908 that hadn't been enforced, and I think that this created such a furor that when this appeared at the Conference in the newspaper the Attorney General of that State, and it was a large State as you can tell by the fact the State put five attorneys to work on that, and sent up a new order by courier to the Mayor, so at least we have shaken something out of the woodwork. But I don't think we are quite that bad here.

Mr. Sidio.

MR. SIDIO: Thank you, Mr. Stein. Governor, Mayor, Mr. Chairman, conferees.

INTRODUCTION

At the request of the Governor of the State of Minnesota, the Public Health Service conducted a pollution evaluation survey of the Red River of the North and its major tributaries during the fall and winter of 1964-65. The purpose of the survey was to obtain data on wastes being discharged to this waterway, and to determine the effect of such wastes on the chemical, biological, and bacteriological quality of the river.

The survey was conducted in three parts: the first, in September, 1964, to ascertain conditions when no beet sugar or potato processing wastes were being discharged; the second, in November, 1964, to determine the effect of seasonal industrial wastes discharged to the waters involved; and the third in January, 1965, to observe conditions under ice cover when municipal and some industrial wastes were being discharged.

This report supplements previous reports prepared on this basin by various Federal and State agencies. It could not have been accomplished without the assistance provided by the Departments of Health and Conservation of the State of Minnesota and the Department of Health of the State of North Dakota; by the cities of Fargo and Grand Forks, North Dakota, for providing sites for mobile laboratory accommodations; by the U. S. Army Corps of Engineers for providing additional required information regarding the Red River complex; and by the U. S. Geological Survey for providing flow data. Excellent cooperation was also received from the American Crystal Sugar Company and its representatives in Moorhead, Crookston, and East Grand Forks, Minnesota.

BACKGROUND

In 1931, '32, and '33 an investigation of the Red River of the North was made by the Minnesota and North Dakota State Boards of Health. Again in February, 1938, the two State Health Departments made a joint investigation of the Red River. It was concluded from the results obtained that " . . . it will be necessary to provide treatment for the sewage and industrial wastes from all of the municipalities from Breckinridge to Grand Forks and East Grand Forks inclusive, and for all the major industrial wastes which are discharged separately into the section of the river under consideration."

In 1944, the interstate ramifications of the pollution led to the establishment of a formal Tri-State Waters Commission and an informal Interstate Sanitation Committee involving the States of North Dakota, Minnesota, and South Dakota in a cooperative effort to solve the water problems of the basin. In 1949, the Committee set up standards recommended for use by the respective regulatory agencies for sewage and waste treatment facilities discharging to the Red River of the North and tributaries. These standards are stated as follows:

"It is recommended that industry and municipalities treat their wastes to the point where the average daily composite 20°C., B.O.D. is 25 ppm, suspended solids 30 ppm, with no peaks running over 50 ppm 20°C., 5-day B.O.D. and 60 ppm suspended solids. Chlorination shall not be used as means of obtaining the B.O.D. reductions although it may be required for other purposes. Certain types of industrial wastes, such as those resulting from the processing of agricultural products, may have to be considered on an entirely different basis.

"It is further recommended that these standards be considered as general only, and that they be subject to modification to meet specific pollutional programs as they develop." Subsequently, these standards were adopted by the respective State regulatory agencies.

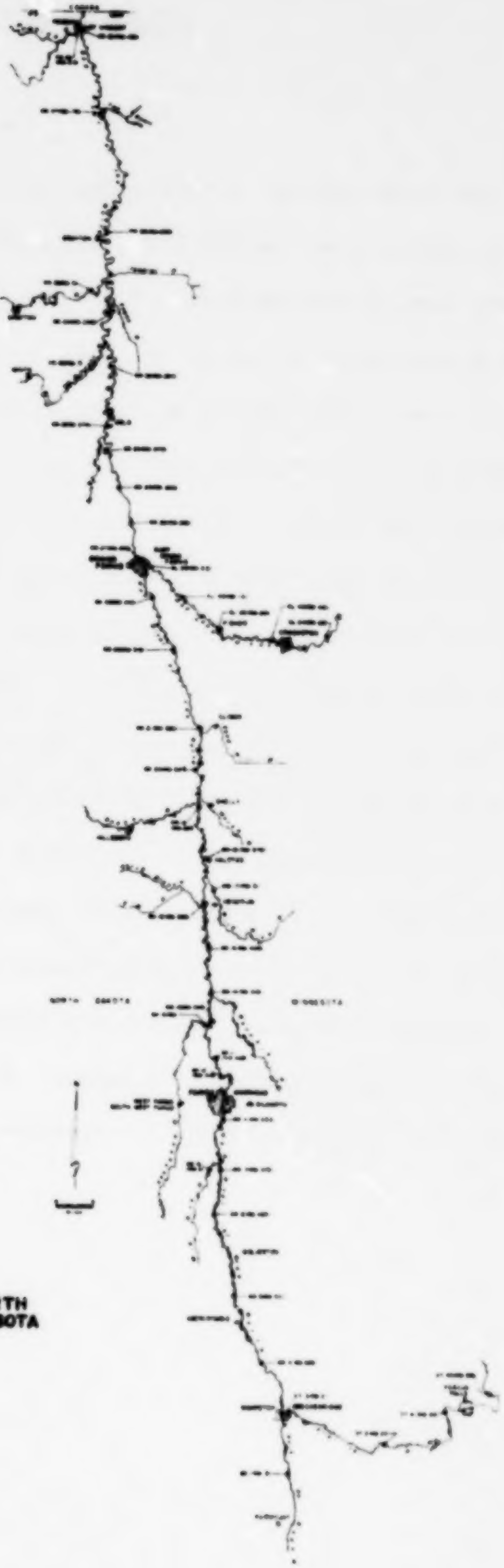
In November, 1951, a cooperative State-Federal report on water pollution in the Missouri-Souris development area and including the Red River of the North basin was issued. This report was prepared by the Public Health Service in close collaboration with the water pollution control agencies of the States in the basin, including North Dakota and Minnesota. The water pollution control agencies reviewed the report and approved its contents as it applies to their respective States. In its consideration of the Red River of the North, the report states that:

"The criteria (of the Interstate Sanitation Committee) essentially establish the principle of secondary treatment for all organic wastes discharging to the Red River or to tributaries where they have an appreciable effect on the Red River."

BASIN DESCRIPTION AND STUDY AREA

The Red River of the North is formed by the confluence of the Ottertail and Bois de Sioux rivers at the twin cities of Wahpeton, North Dakota, and Breckinridge, Minnesota, and flows north for 549 river miles to Lake Winnepeg, Canada: 394 river miles are in the United States. The river forms the boundary between the States of Minnesota and North Dakota. It slopes very gently toward the north, falling about 200 feet in 400 miles within the United States through both impounded and unimpounded stretches. Tributary river systems of major importance are the Ottertail River, the Sheyenne River, the Red Lake River, and the Pembina River. The Red River Valley was, in prehistoric times, the bed of an inland glacial lake which varied in width from 15 to 70 miles. The plain of the Red River Valley is composed of a very rich black earth, which is exceptionally well suited for agricultural purposes, particularly the cultivation of wheat, sugar beets, and potatoes. The metropolitan areas of Fargo-Moorhead and Grand Forks-East Grand Forks serve the principally agricultural economy as rail and trucking centers.

The study area may be divided into four parts. The first was the Ottertail River from above Fergus Falls to Breckinridge, Minnesota, and the upper Red River from Wahpeton-Breckinridge to Fargo-Moorhead, having a total of 146 river miles. The second consisted of the Red River between Fargo-Moorhead and Grand Forks-East Grand Forks, with 164 river miles. The third was the Red Lake River from above Crookston to its confluence with the Red River at Grand Forks-East Grand Forks, 66 river miles. The fourth reach extended on the Red River from Grand Forks-East Grand Forks to the International Boundary; this amounted to 143 river miles. A total of 519 river miles was involved in the three phases of this study. The entire study area is shown in Chart 1.


NORTH DAKOTA
MINNESOTA

RED RIVER OF THE NORTH
NORTH DAKOTA – MINNESOTA

STUDY AREA

CHART 1

METHOD OF STUDY

The three phases of this study involved a total of 43 river sampling stations on the Red River and nine of its tributaries. The main stem of the Red River of the North had 27 sampling locations from Wahpeton-Breckinridge to the International Boundary. Five stations were located on the Red Lake River from above Crookston, Minnesota to the confluence with the Red River at East Grand Forks, Minnesota. The Ottertail River had four sampling stations from above Fergus Falls to its mouth in Breckinridge, Minnesota. Seven other tributaries had sampling stations located near their confluence with the Red River to monitor the effect of their water quality upon the interstate waters of the Red River. These tributaries included the Bois de Sioux River, the two Wild Rice rivers in North Dakota and Minnesota, the Sheyenne River, the Forest River, the Park River, and the Pembina River. In addition, the wastes from six industrial users, including the three sugar refining plants of the American Crystal Sugar Company at Moorhead, East Grand Forks and Crookston, Minnesota, were intensively sampled during periods of plant operation. A description of all sampling stations is contained in Table 1.

Table 1
Red River of the North
North Dakota - Minnesota
Sampling Station Location Guide

Station Number	River Mileage	Description
BD-1	549-9	Bois de Sioux River highway bridge near Tyler, N.D.
OT-2	549-27	Ottertail River highway bridge, 8 miles east of Doran, Minnesota
OT-3	549-1	Ottertail River highway bridge, 4th Street N. and Andrews Avenue, Breckinridge, Minnesota
	549	U.S.G.S. gage, Wahpeton, North Dakota
RR-4	536	Red River of the North highway bridge near Brushvale, Minnesota
RR-5	501	Red River of the North highway bridge near Enloe, North Dakota
RR-6	483	Red River of the North highway bridge near Comstock, Minnesota
RR-7	472	Red River of the North highway bridge near Wild Rice, North Dakota
WD-8	470-2	Wild Rice River highway bridge near Wild Rice, North Dakota
RR-9	462	Red River of the North, Interstate 94 highway bridge, Fargo, North Dakota
RR-10	441	Red River of the North highway bridge, N.E. of Fargo Airport, Fargo, North Dakota
RR-11	436	Red River of the North bank sample on private property, 4 miles N. of Moorhead, Minnesota
RR-12	426	Red River of the North bank sample on private property, near Kragnes, Minnesota
SH-13	428-1	Sheyenne River highway bridge, Cass County Rd. 81, 8 miles N. of Fargo, N.D.

Table 1 (Cont.)

Red River of the North

North Dakota - Minnesota

Sampling Station Location Guide

Station Number	River Mileage	Description
RR-14	416	Red River of the North highway bridge near Georgetown, Minnesota
RR-15	403	Red River of the North highway bridge near Perley, Minnesota
RR-16	386	Red River of the North highway bridge near Hendrum, Minnesota
WM-17	380-3	Wild Rice River near Hendrum, Minnesota
RR-18	375	Red River of the North highway bridge near Halstad, Minnesota Also U.S.G.S. gage
RR-19	357	Red River of the North highway bridge near Shelby, Minnesota
RR-20	347	Red River of the North highway bridge near Nielsville, Minnesota
RR-21	335	Red River of the North highway bridge near Climax, Minnesota
RR-22	319	Red River of the North highway bridge near Bygland, Minnesota
RR-23	305	Red River of the North bank sample on private property, 4 miles S. of East Grand Forks, Minnesota
RL-24	298-66	Red Lake River highway bridge, 5 miles E. of Crookston, Minn.
	298-51	U.S.G.S. gage, Crookston, Minn.
RL-25	298-28	Red Lake River highway bridge at Fisher, Minnesota
RL-26	298-0	Red Lake River Highway 220 bridge at East Grand Forks, Minnesota

Table 1 (Cont.)

Red River of the North

North Dakota - Minnesota

Sampling Station Location Guide

Station Number	River Mileage	Description
RR-27	298	Red River of the North, Demers Ave. bridge, Grand Forks, N. D. - East Grand Forks, Minn.
	296	U.S.G.S. gage, Grand Forks, N. D.
RR-28	292	Red River of the North bank sample on private property, 4 miles N. of East Grand Forks, Minn.
RR-29	286	Red River of the North bank sample on private property, near Northland, Minn.
RR-30	279	Red River of the North bank sample on private property, 2 miles S. of Oslo, Minn. on North Dakota side of the river.
RR-31	274	Red River of the North highway bridge at Oslo, Minnesota Also U.S.G.S. gage, Oslo, Minn.
RR-32	254	Red River of the North bank sample on private property near Big Woods, Minn.
FR-33	243-7	Forest River, Highway 44 bridge, N. D.
RR-34	236	Red River of the North highway bridge east of Grafton, N. D.
PR-35	222-5	Park River, Highway 44 bridge, N. D.
RR-36	208	Red River of the North highway bridge at Drayton, N.D. Also U.S.G.S. gage, Drayton, N. D.
RR-37	176	Red River of the North bank sample on private property near Joliette, N. D.
PE-38	158-D	Pembina River highway bridge at Pembina, N. D.
RR-39	158	Red River of the North highway bridge at Pembina, N.D.
	155	International Border
	154	Canadian Gaging Station, Emerson, Manitoba

Table 1 (Cont.)
Red River of the North
North Dakota - Minnesota
Sampling Station Location Guide

Station Number	River Mileage	Description
OT-40	549-67	Ottertail River highway bridge, 4 miles E. of Fergus Falls, Minn.
OT-41	549-49	Ottertail River highway bridge, 2.5 miles W. of Fergus Falls, Minn.
RL-42	298-14	Red Lake River highway bridge near Mallory, Minn.
RL-43	298-49	Red Lake River bank sample as municipal lagoons, Crookston, Minn.
SM-44		American Crystal Sugar Co., Moorhead, Minn. plant outfall
SC-45		American Crystal Sugar Co., Crookston, Minn. plant outfall
SE-46		American Crystal Sugar Co., East Grand Forks, Minn. plant outfall
RP-47		Rogers Brothers Potato plant, Grand Forks, N. D. plant outfall
PP-48		Pillsbury Potato plant, Grand Forks, N. D. plant outfall
FP-49		Frito-Lay Potato plant, Grand Forks, N. D. plant outfall
SM-50		North Dakota State Mill, Grand Forks, N. D. sewer outfall

RIVER DISCHARGE

During each phase of the study, flows were obtained at each of the sampling stations with the assistance of the U. S. Geological Survey. These values are listed in Table 2. These data show that there were no extreme variations in river discharge at any point during the individual sampling periods. During the September, 1964 survey, the discharge in the river and tributary system was below the average that normally occurs. In October-November, and in January, discharge was about the average monthly flow at Fargo. At Crookston and Grand Forks, during this period, discharge was about twice the average monthly flow due to an abnormally high release of water from the flood control dam on the Red Lake River. These flood control dams, located on the Ottertail and Red Lake rivers, are maintained by the Corps of Engineers. During low water periods, releases are made from these reservoirs to meet downstream water requirements including water supply and waste disposal. These releases are coordinated.

The Red River of the North exhibits a large increase in flow from its headwaters to the International Boundary. The Ottertail River normally supplies 90 percent of the flow to the Red River at its inception at Wahpeton-Breckinridge. Downstream at Fargo-Moorhead,

Table 2

River Discharges

Red River of the North & Tributaries

Station	River Mile	River Discharge (cfs) Sept.	 Nov.	 Jan.
Red River of the North				
RR- 9	462	70	234	189
RR-10	441	75	230	194
RR-11	436	76	229	190
RR-12	426	148	292	
RR-14	416	182	318	265
RR-15	403	185	319	262
RR-16	386	187	316	260
RR-18	375	218	380	292
RR-19	357	225	378	295
RR-20	347	232	384	300
RR-21	335	298	401	312
RR-22	319	325	401	315
RR-23	305	333	401	315
RR-27	298	607	1512	955
RR-28	292	625	1515	952
RR-29	286	648	1525	949
RR-30	279	662	1525	946
RR-31	274	698	1545	940
RR-32	254	711	1561	933
RR-34	236	739	1591	928
RR-36	208	766	1611	922
RR-37	176	800	1562	907
RR-39	158	868	1524	898

Table 2 (Cont.)

River Discharges

Red River of the North & Tributaries

Station	River Mile	River Discharge (cfs) Sept.	Nov.	Jan.
Red Lake River				
RL-24	298-66	247	1063	
RL-43	298-49		1065	
RL-25	298-28	254	1093	
RL-42	298-14		1106	
RL-26	298- 0	276	1115	647
Tributaries				
OT-2	549-20	69		
OT-3	549-2	77		
BD-1	549-9	6		
WD-8	468-2	1		
SH-13	428-1	67	64	69
WM-17	380-3	29	67	33
FR-33	243-7	6	11	
PR-35	222-5	8	7	
PE-38	158-0.5	113	50	5
Upper Red River				
RR-4	536	85		
RR-5	501	83		
RR-6	483	73		
RR-7	472	71		

The Sheyenne River adds from 20 to 100 percent of the flow in the Red River depending on the season of the year. The Red Lake River effectively doubles the discharge of the Red River at Grand Forks - East Grand Forks. The discharge of the Red River normally is ten times greater at the International Boundary than at Fargo. This is due primarily to the inflow from the major tributaries, notably the Sheyenne and Red Lake rivers.

WATER USAGE

Water usage in the Red River study area is principally for domestic and industrial water supply and waste disposal. However, there is some agricultural use, such as irrigation. Fishing, especially ice fishing, is quite popular and constitutes the major recreational use. There is limited pleasure boating in the impounded areas.

DOMESTIC WATER SUPPLY

Within the study area, the rivers are used as sources of domestic water supply by approximately 161,000 people, a great majority of the area's population. Fifty-six thousand of these are in Minnesota and 105,000 are in North Dakota. Fargo, North Dakota, obtains its water supply from the Red River of the North. The city of Grand Forks has two intakes; one on the Red River of the North above the city, and the other on the Red Lake River. Comparison of water quality in both rivers dictates the choice of intake to be used in supplying the domestic needs for the city. Other major users of the rivers for municipal water supply include Fergus Falls, Breckinridge, Crookston, and East Grand Forks, Minnesota, and Wahpeton, Drayton and Pembina, North Dakota. Domestic water users are listed in Table 3.

Table 3
Domestic Water Supply
Red River Study Area

Community	Population Served	Source of Supply
Fergus Falls, Minn.	14,000	Ottertail River
Wahpeton, North Dakota	6,000	Red River & Ottertail R.
Breckinridge, Minn.	4,500	Ottertail River
Fargo, North Dakota	49,000	Red River of the North
Grand Forks, N. D.	48,140	Red River & Red Lake R.
East Grand Forks, Minn.	7,300	Red Lake River
Crookston, Minn.	9,500	Red Lake River
Oslo, Minn.	370	Red River of the North
Drayton, N. D.	950	Red River of the North
Pembina, N. D.	625	Pembina River

INDUSTRIAL WATER SUPPLY

Industrial water use in the study area is estimated at about fifteen million gallons per day (MGD). Principal users are the American Crystal Sugar Company's beet processing plants located at Moorhead, Crookston, and East Grand Forks, Minnesota; several potato processing plants located principally in Grand Forks, North Dakota; and a meat packing and rendering plant in Fergus Falls. With the exception of the meat packing and rendering plant, these operations are seasonal, occurring during the fall and winter months. Steam electric generating plants, located in Fargo, Grand Forks and Fergus Falls, use about 40 MGD of river water for cooling purposes.

RECREATION

Although the Red River at present is not intensively developed for recreational purposes, there is some potential for an increase in this use. Impoundments in the Red River at Fargo-Moorhead result in a pool of more than twenty miles in length which is suitable for small pleasure boating. There is also a pool in the Red River at Grand Forks which extends for about thirty-nine river miles. Limited pleasure boating was observed in this pool during this study.

Fishing may be observed frequently in all areas, in open water and under the ice. The most intensive fishing location observed during this study was in the tailrace of the last dam downstream in Fargo-Moorhead. This dam is only a few feet upstream from the outfall of the Moorhead sewage treatment plant. During winter, ice fishing shanties could be seen everywhere, but were especially numerous at the mouth of the Red Lake River at East Grand Forks. Sport fishing represents the major recreational use at the present time.

AGRICULTURE

Agriculture represents the pillar upon which the economy of the area is built. Without a highly productive agricultural output, the economic well being of the region will suffer. Since this region has poorly distributed rainfall characteristics over the year, water conservation is a necessity and some irrigation of crops is carried on. Because the ground waters of the area are inadequate in quantity and of poor quality, the conservation must be accomplished on the surface water resources. If the quality of surface water is poor, it cannot be used for irrigation purposes. Cattlemen who depend on the rivers for stock water would be forced to either import water or to cut down the size of their herds. The drop in productivity due to inadequate surface water quality would adversely affect existing industry and hinder the development of new industry.

WASTE DISCHARGES

The Red River and its tributaries are used extensively for the disposal of wastes, both municipal and industrial, which cause serious water quality degradation in certain reaches.

DOMESTIC WASTES

The strength of sewage commonly is measured in terms of three constituents: oxygen demand, bacterial content, and suspended solids. These may be expressed in population equivalents, the units of which are the average contribution of these constituents made by an individual in a day. The domestic waste facilities which discharge at various times to the Red River of the North and its tributaries within the study area and the contribution of each in population equivalents are listed in Table 4.

Most communities in the basin use waste stabilization ponds and discharge intermittently to the receiving streams. From those communities who employ other methods of treatment or none at all, there was a continuous daily discharge of domestic wastes to the Red River of the North and its tributaries with a total oxygen demand of 37,530 population equivalents (P.E.). The corresponding values for

Table 4
Domestic Waste Discharges
Red River of the North

Municipality	Receiving Waterway	Population Served	Type of Treatment	Population Equivalents Discharged		
				Oxygen Demand	Bacterial	Suspended Solids
Minnesota						
Fergus Falls	Ottertail River	29000*	Secondary & Cl.	14700	2900	2500
Wolverton	Red River of the North	180	Primary	120	90	90
Moorhead	Red River of the North	48700**	Secondary & Cl.	13000	2100	7000
Halstad	Red River of the North	580	None	580	580	580
Shelly	Marsh River	280	W.S.P.***	30	5	10
Climax	Sand Hill River	280	None	280	280	280
Crookston	Red Lake River	7690	W.S.P.	770	80	250
East Grand Forks	Red River of the North	6300	W.S.P.	630	60	180
Total from Minnesota		93010		30110	5695	10890
North Dakota						
Fairmount	Bois de Sioux River	500	None	500	500	500
Wahpeton	Red River of the North	4700	W.S.P.	470	50	150
Abercrombie	Red River of the North	200	Primary	140	120	120
Fargo	Red River of the North	47000	Secondary	7300	4700	6900
West Fargo	Sheyenne River	120	Secondary	12	12	12
Southwest Fargo	Sheyenne River	3000	W.S.P.	300	30	90
Grand Forks	Red River of the North	30000	W.S.P.	3000	300	900
Grafton	Park River	5640	W.S.P.	560	50	150
Drayton	Red River of the North	910	None****	910	910	910
Pembina	Pembina River	485	W.S.P.	50	5	15
Total from North Dakota		92555		13242	6677	9747

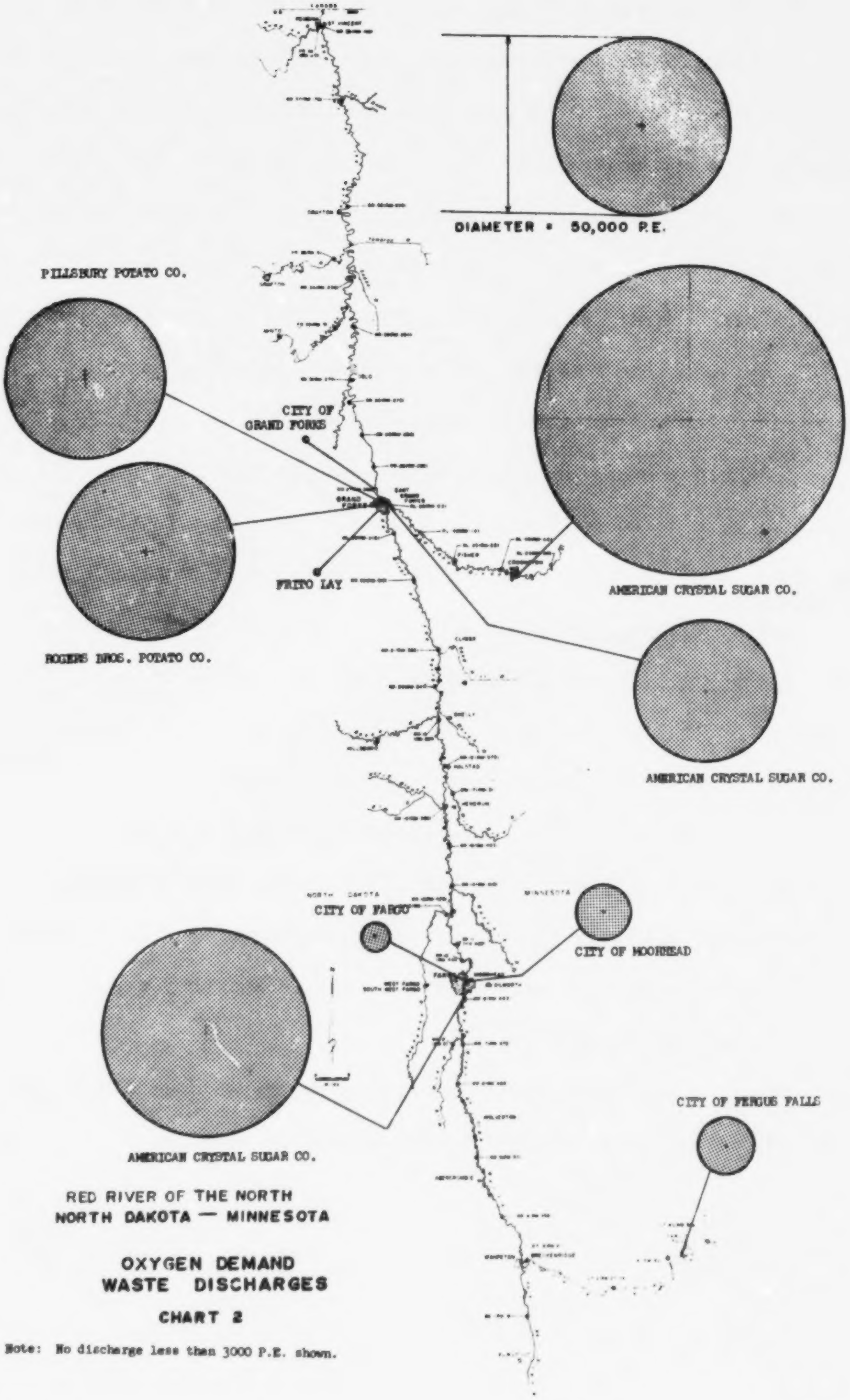
* 16600 Industrial P.E.
** 28000 Industrial P.E. estimated from plant records.
*** Waste stabilization ponds. Overall removal of B.O.D. is greater than 90% on a concentration basis.
**** Stabilization pond treatment begun in 1965.

bacterial (B.P.E.) and suspended solids (S.S.P.E.) were 9650 and 19000 population equivalents respectively. Most of this daily contribution was from the metropolitan and industrial center of Fargo-Moorhead. The raw sewage P.E. from this complex was 67,640. Both communities provide biological secondary treatment of their wastes and the combined population equivalents of the effluents from the two treatment plants are: oxygen demand P.E. 20,300; B.P.E. 6,800; and S.S.P.E. 13,900. The Moorhead plant, however, contributes about two-thirds of the oxygen demand waste effluent.

Of those communities that provide no treatment, Halstad, Minnesota, with a sewered population of 580, has plans in the design stage for construction of a secondary treatment plant, while Drayton, North Dakota, with a population of 950, has a waste stabilization pond under construction which will be ready for operation in 1965. Fairmount, North Dakota, and Climax, Minnesota, with a total population of 780, continue to discharge their wastes with no treatment.

Most of the remaining sewage discharges in the study area that may affect the quality of interstate waters occur intermittently due to the seasonal lowering of stabilization pond levels. These ponds provide about six months' storage to the wastes and they are discharged during the spring and fall seasons.

Charts 2 and 3 illustrate the relative oxygen demand P.E. and the B.P.E. of wastes discharged to the receiving streams.

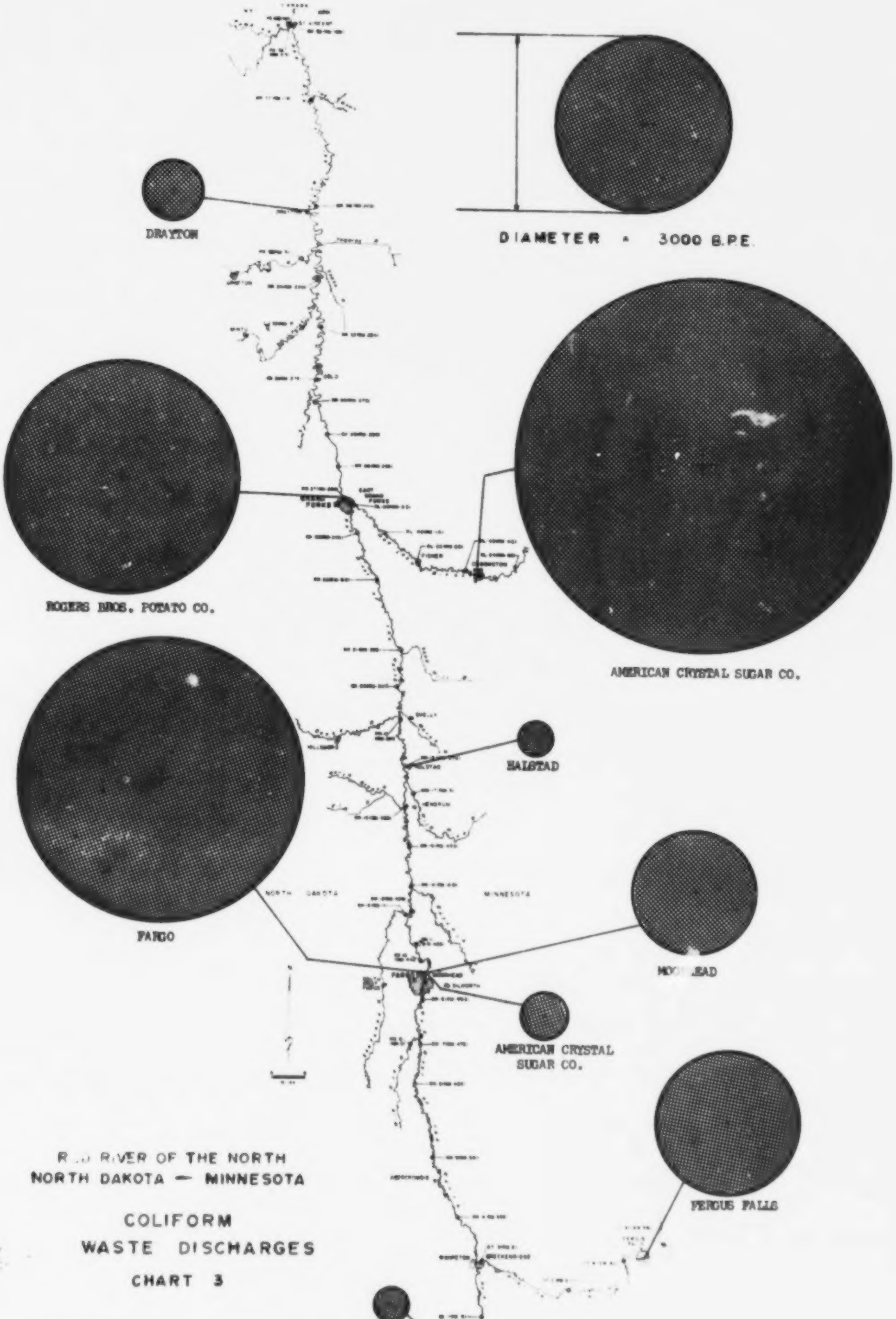

DIAMETER = 50,000 P.E.
PILLSBURY POTATO CO.
CITY OF GRAND FORKS
FRITO LAY
ROGERS BROS. POTATO CO.
AMERICAN CRYSTAL SUGAR CO.
AMERICAN CRYSTAL SUGAR CO.
NORTH DAKOTA
MINNESOTA
CITY OF FARGO
CITY OF MOORHEAD
AMERICAN CRYSTAL SUGAR CO.
CITY OF FERGUS FALLS

RED RIVER OF THE NORTH
NORTH DAKOTA — MINNESOTA

OXYGEN DEMAND WASTE DISCHARGES

CHART 2

Note: No discharge less than 3000 P.E. shown.


DIAMETER = 3000 B.P.E.
DRAYTON
ROGERS BROS. POTATO CO.
AMERICAN CRYSTAL SUGAR CO.
HALSTAD
FARGO
NORTH DAKOTA
MINNESOTA
MOORHEAD
AMERICAN CRYSTAL SUGAR CO.
FERGUS FALLS
FAIRMOUNT

RED RIVER OF THE NORTH
NORTH DAKOTA — MINNESOTA

COLIFORM
WASTE DISCHARGES
CHART 3

Note: No discharge less than 500 B.P.E. shown.

INDUSTRIAL WASTES

Industrial wastes, within the study area, are primarily those from the processing of agricultural products, especially potatoes and sugar beets. Chart 2 shows the relative oxygen demand P.E. of industrial wastes discharged to the receiving streams.

The American Crystal Sugar Company currently operates sugar beet processing plants at Moorhead, Crookston, and East Grand Forks, Minnesota, and has a fourth plant under construction at Drayton, North Dakota. The discharge of wastes from these plants is regulated by the State of Minnesota depending on stream flow. These plants begin operation in the fall, usually soon after Labor Day, and operate on a daily 24-hour schedule until the supply of beets is exhausted. A normal campaign runs about 150 days. However, the waste discharge schedule does not correspond to the campaign schedule. From the beginning of the campaign until the ice cover on the receiving streams near 100 percent, wastes are discharged from the plants to lagoons and to the river with little detention in the lagoons. When ice cover is complete, the lagoon outlets are closed and the wastes are stored until spring for release during periods of high river flow. Table 5 indicates the population equivalents of the three sugar plant discharges during the survey period of October-November, 1964. Totals of 191,000 oxygen demand P.E., 7,135 B.P.E., and 38,000 S.S.P.E. were discharged by the three plants.

Three potato processing plants in Grand Forks, North Dakota, discharge directly to the Red River of the North. Operations of the

Table 5
Industrial Waste Discharges*
Red River of the North

Plant	State	Receiving Waterway	Treatment	Population Equivalents Discharged		
				B.O.D.	Bacteria	Suspended Solids
American Crystal Sugar Co. Moorhead	Minn.	Red River of the North	Lagoons	62,100	765	18,350
American Crystal Sugar Co. Crookston	Minn.	Red Lake River	Lagoons	89,300	6,350	9,000
American Crystal Sugar Co. East Grand Forks	Minn.	Red River of the North	Lagoons	39,400	-	10,700
Rogers Brothers Potato Co. Grand Forks	N. D.	Red River of the North	Primary	52,700	3,910	105,500
Pillsbury Potato Co. Grand Forks	N. D.	Red River of the North	None**	46,000	-	68,500
Frito Lay Potato Co. Grand Forks	N. D.	Red River of the North	Primary	3,000***	-	-
Total Industrial Wastes				292,500	11,045	212,000

* These figures obtained during Oct.-Nov. 1964 PHS Survey.
** Primary provided - not in use at time of sampling.
*** Estimated.

Rogers Brothers and Pillsbury plants are seasonal during the fall and winter months, depending upon the supply of potatoes. Table 5 indicates the population equivalents of the potato plant wastes during the October-November, 1964 phase of the survey. Totals of 101,700 oxygen-demanding P.E. and 174,000 S.S.P.E. were discharged by the three plants. The Frito-Lay Company was not in operation due to an equipment breakdown, and the estimate of 3,000 P.E. was obtained from other sources. The wastes being discharged from these plants have extremely high concentrations of oxygen demand and suspended solids. The excessive suspended solids (174,000 P.E.) discharged from these potato plants settle out in the stream and destroy bottom-associated organisms which serve as a food supply for fish. The Rogers Brothers plant, where a steam type peeling process is used, contributed significant quantities of bacteria amounting to 3910 B.P.E. In the future, these potato plant wastes, after effective primary treatment has been provided at the plant, will be collected and treated in the Grand Forks municipal system.

WASTE TOTALS

During this study there was a daily discharge of wastes, both municipal and industrial, to the Red River of the North and its tributaries of 330,230 oxygen-demanding P.E.; 20,965 B.P.E.; and 231,000 S.S.P.E. Two hundred nineteen thousand population equivalents of oxygen-demanding wastes or 66 percent of the total were discharged in Minnesota and the remainder in North Dakota. Seventy-nine percent or 183,000 S.S.P.E. were discharged in North Dakota. Each State contributed about an equal amount of B.P.E.

For municipal wastes alone, Minnesota contributed 28,560 P.E., or 76 percent of the daily load on an oxygen demand basis. For industrial wastes, Minnesota contributed 191,000 oxygen demand P.E. or 65 percent of the total. For suspended solids, North Dakota contributed 174,000 S.S.P.E., or 82 percent of the total.

EFFECTS OF POLLUTION ON WATER QUALITY

BIOCHEMICAL OXYGEN DEMAND AND DISSOLVED OXYGEN

Sewage and many industrial wastes contain organic matter that decomposes and exerts an oxygen demand in the receiving waters. In the process of decomposition, oxygen derived from the atmosphere and dissolved in the water is reduced below its normal level of concentration to satisfy this biochemically degrading organic material. High concentrations of oxygen-demanding material will cause an excessive reduction of the dissolved oxygen resources which, in turn, will result in a reduction of desirable aquatic life and fish population. If the wastes are strong enough to cause a complete depletion of the dissolved oxygen, offensive odors will result.

Neither the State of Minnesota nor the State of North Dakota has established a dissolved oxygen standard for the waters of the Red River of the North or its tributaries. Both States, however, support the use of the standards of the Missouri Basin Health Council which recommend a minimum D.O. of 5.0 mg/l. If the States desire a higher quality than that recommended in this report, the objectives of the Federal Government with regard to the effects of interstate pollution on the oxygen resources in the Red River will be accomplished.

Ottertail River and Upper Red River

This section of the study area does not have an intensively developed water use since it consists mainly of many small agricultural communities. The waste loads discharged are relatively small and the average biochemical oxygen demand (B.O.D.) in this reach was 3 mg/l. There is one major source of continuous waste at Fergus Falls, Minnesota. Fergus Falls discharges effluent from a secondary sewage treatment plant that includes wastes from a packing and rendering plant, to the Ottertail River above the Orwell flood regulation dam. Whatever oxygen-demanding material remains after treatment becomes diluted in the impoundment. In addition, the time of passage is increased appreciably, allowing for satisfaction of any B.O.D. in the immediate area.

The observed dissolved oxygen (D.O.) values are shown in Chart 4. In this section, no average D.O. value was less than 7.5 mg/l. Since the results of this phase of the survey in this section revealed no interstate pollution problems and since waste loads remain relatively constant, it was not considered necessary to sample during the latter two study periods.

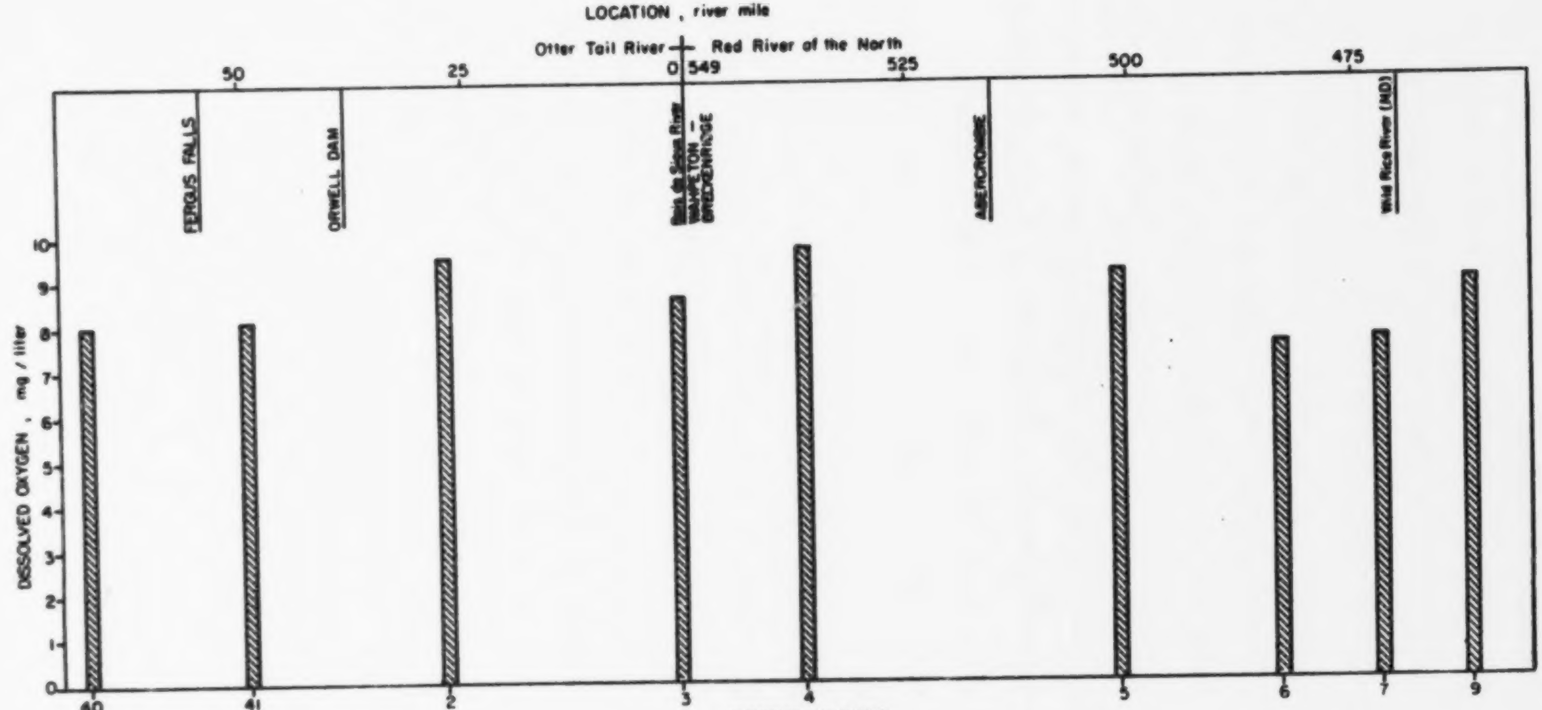


Chart 4

RED RIVER OF THE NORTH
North Dakota — Minnesota
Otter Tail and Upper Red River
DISSOLVED OXYGEN

Red River of the North - Fargo to Grand Forks

The mean values obtained in this stretch are summarized in Table 6 and are illustrated in Chart 5.

During September the American Crystal Sugar Company's beet processing plant at Moorhead was not in operation and was not discharging wastes to the river. The condition of the river during September reflected the effects of the discharges from the two secondary sewage treatment plants at Fargo and Moorhead and from any contribution of waste materials by the tributaries. From immediately above Fargo-Moorhead to immediately below the two sources of municipal wastes, there was an increase of 15,000 population equivalents (P.E.) of B.O.D. The exertion of the oxygen demand of these wastes was immediately reflected in the D.O. concentrations in the stream. From 8.9 mg/l above the sewage plant discharges the concentration dropped to 4.4 mg/l below. Individual values of D.O. at this point were as low as 2.0 mg/l. The D.O. recovered through reaeration until it reached a value greater than saturation at a point 45 miles downstream.

During November, the beet sugar plant at Moorhead was operating on a 24-hour, 7-day week schedule, and was discharging waste with an average B.O.D. of 62,000 P.E. The two municipal plants continued to discharge. The increased organic loading imposed a marked reduction in D.O. The D.O. dropped from 10.8 mg/l above Fargo-Moorhead to 3.5 mg/l at a point 12 miles downstream. Individual values of D.O. at this point were as low as 2.0 mg/l. The river then recovered until it reached its pre-waste level of D.O. at Halstad, Minnesota, a distance of 73 miles downstream from the sources of waste.

Table 6
Dissolved Oxygen
Red River of the North
Fargo to Grand Forks
Sept.-Nov. 1964

Station	River Mile	Dissolved Oxygen Sept. mg/l	Dissolved Oxygen Nov. mg/l
RR- 9	462	8.9	10.8
RR-10	441	4.4	5.8
RR-11	436	5.9	3.5
RR-12	426	8.1	4.8
RR-14	416	8.3	6.5
RR-15	403	10.0	8.0
RR-16	386	12.4	10.0
RR-18	375	14.0	11.1
RR-19	357	11.7	12.2
RR-20	347	9.9	12.9
RR-21	335	9.0	13.6
RR-22	319	8.1	14.8
RR-23	305	6.9	16.2

Table 6 (Cont.)
Dissolved Oxygen
Red River of the North
Fargo to Grand Forks
January, 1965

Station	River Mile	Dissolved Oxygen 1 mg/l	Dissolved Oxygen 2 mg/l
RR- 9	462	12.7	12.7
RR-10	441	10.6	11.3
RR-11	436	9.3	9.0
RR-14	416	4.4	6.1
RR-15	403		5.9
RR-16	386	4.1	5.2
RR-18	375	4.8	4.9
RR-19	357	2.5	3.4
RR-20	347	2.7	3.9
RR-21	335	3.3	5.0
RR-22	319	1.1	4.2
RR-23	305		3.0
Grand Forks water intake	300		2.4

1 - Mean of values resulting from ACS-Moorhead clean-up operation.

2 - Mean of values not affected by ACS-Moorhead clean-up operation.

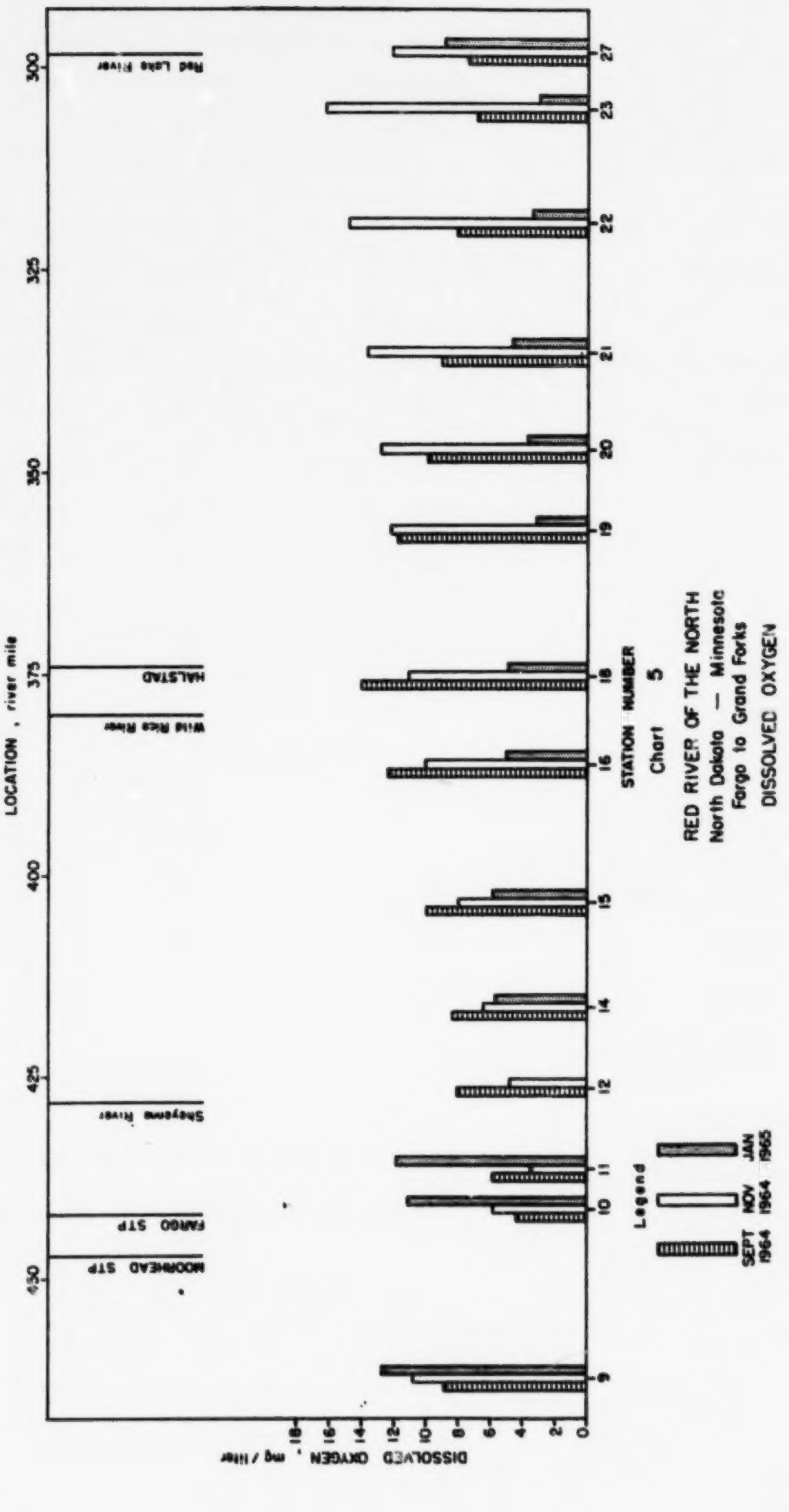


Chart 5

RED RIVER OF THE NORTH
North Dakota — Minnesota
Fargo to Grand Forks
DISSOLVED OXYGEN

In September and November, the D.O. continued to increase downstream from the points of minimum D.O. and supersaturated concentrations occurred. The highest mean values were 14 mg/l at Halstad in September and 16.2 mg/l in the impoundment above Grand Forks in November. This production of oxygen was caused by algae growths in the river. Downstream of R.M. 347 in September, the production of oxygen by algae was no longer apparent. The D.O. in this reach dropped from 9.9 mg/l at R.M. 347 to 6.9 mg/l at R.M. 305. Algae cannot be considered beneficial to the stream since a serious additional demand on the oxygen resources may be created by their respiration and by their decomposition when the supply of nutrients for their growth has been depleted. The excessive algal growth in this reach of river was caused by the discharge of wastes from domestic and industrial sources at Fargo and Moorhead.

The survey conducted under ice cover in January, 1965, revealed a totally different picture of the oxygen balance than that observed in September and November. The beet sugar plant at Moorhead was discharging clean-up wastes for four days at the beginning of the survey, in violation of the permit for discharge issued by the State of Minnesota. When the beet sugar plant was not discharging, the increase in B.O.D. was 24,000 P.E. During the four days when the beet sugar plant was discharging, the increase in B.O.D. was 72,000 P.E. The decrease in D.O. was more pronounced under the increased loading from the sugar plant waste. At Grand Forks, the D.O. approached depletion (2.4 mg/l) due to the waste discharges of the Fargo and Moorhead municipal treatment plants. The D.O. dropped to zero at the Grand Forks water intake under the conditions of increased demand added by the discharge of the sugar plant.

Red Lake River - Crookston to Grand Forks

Table 7 summarizes the data observed in this stretch.

During September, the only source of pollution to this stretch was the discharge from the lagoon at Crookston. The increase in B.O.D. from this discharge amounted to 3,000 P.E., and there was a slight drop in the D.O. from 9.2 mg/l to 8.8 mg/l. Chart 6 represents the D.O. profile in the river.

In November, the American Crystal Sugar Company plant at Crookston was discharging wastes to the river. The increase in B.O.D. below the discharge was 118,000 P.E. The release from the Red Lake flood control dam during this period was substantially above the expected flow. Oxygen resources from the increased flow (1065 cfs) and from atmospheric reaeration prevented a sharp drop in D.O., such as occurred below Fargo-Moorhead (234 cfs). The D.O. was reduced only 1.5 mg/l in this stretch before starting to recover. The B.O.D. observed in the Red Lake River immediately before its confluence with the Red River was 92,000 P.E. No significant numbers of algae, and no meaningful production of oxygen, were observed in this stretch.

During January, 1965, there was no discharge from the sugar plant and a monitoring station in East Grand Forks showed the D.O. to be 11.6 mg/l after prolonged ice cover. This indicated little demand on the oxygen resources.

Table 7

Dissolved Oxygen

Red Lake River

Crookston to Grand Forks

Station	River Mile	Dissolved Oxygen Sept. mg/1	Dissolved Oxygen Nov. mg/1	Dissolved Oxygen Jan. mg/1
RL-24	298-66	9.2	12.0	
43	298-46		11.2	
25	298-28	8.8	10.7	
42	298-14		11.4	
26	298-0	8.5	10.6	11.6

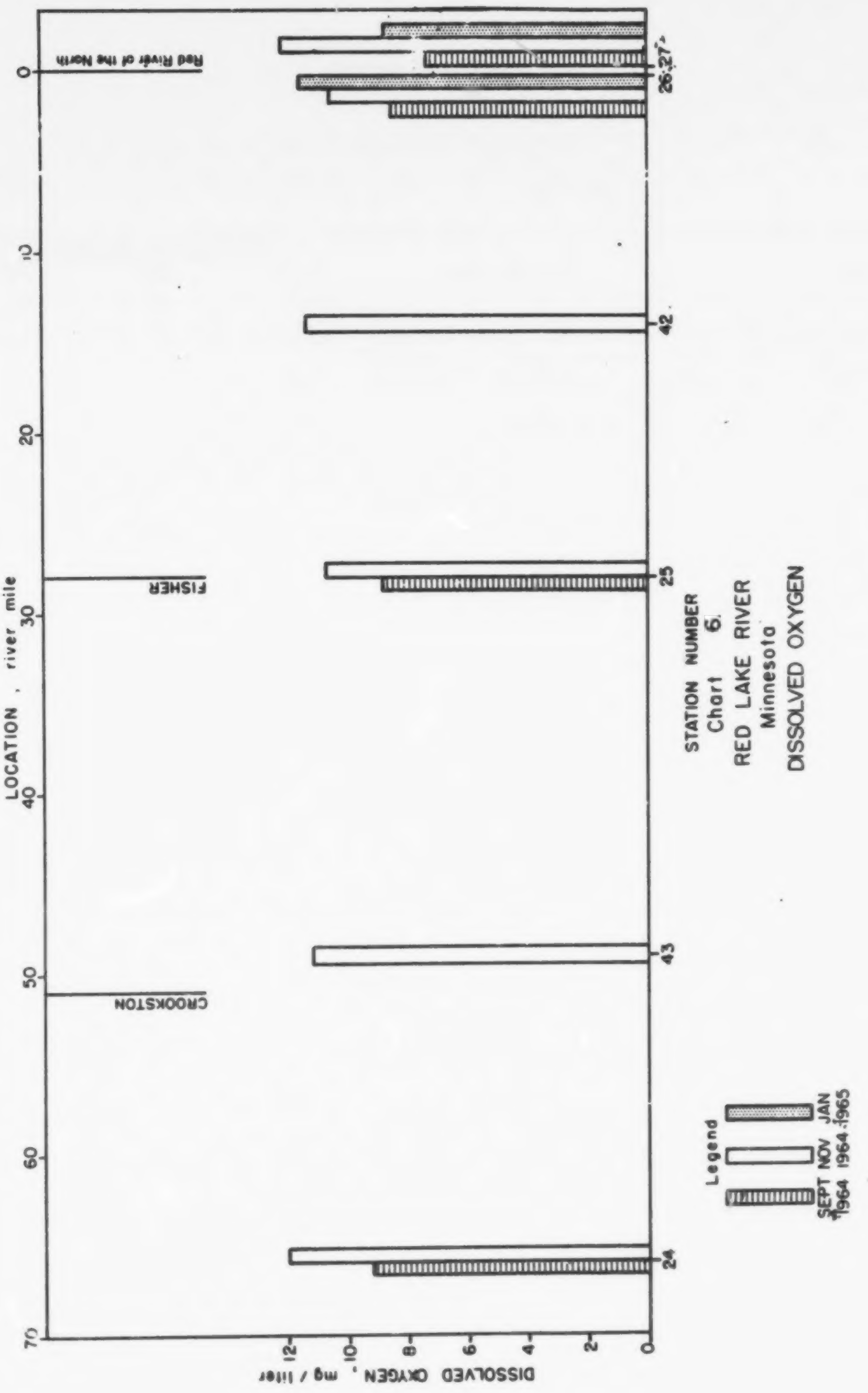


Chart 6.
RED LAKE RIVER
Minnesota
DISSOLVED OXYGEN

Red River of the North - Grand Forks to International Boundary

The results obtained in this stretch are summarized in Table 8 and illustrated in Chart 7. During the September phase of the survey, the sources of pollution to this stretch were the residual pollution from Fargo-Moorhead and the discharge from the municipal waste stabilization ponds at Grand Forks and East Grand Forks. The D.O. in the river at R.M. 298 downstream of the confluence with the Red Lake River was 7.4 mg/l. The B.O.D. between R.M. 298 and R.M. 292 increased 25,000 population equivalents, due to the discharge from the two municipal waste stabilization ponds. There was no decrease of the D.O. at these loadings and the minimum discharges plus the increased dilution prevented damage during September. Although B.O.D. values were extremely high in the Park and Forest rivers, tributary to the Red in this stretch, the very low flows do not permit this waste to measurably affect the Red River.

In November, industries were discharging wastes in the Grand Forks-East Grand Forks area. The wastes included those from the American Crystal Sugar Company in East Grand Forks and from the Rogers Bros., Pillsbury, and Frito Lay potato plants in Grand Forks. The municipal waste stabilization ponds were also discharging during this period. Residual oxygen demand from the Red Lake River and from the Red River above Grand Forks contributed to the total oxygen demand below Grand Forks. The combined industries in Grand Forks-East Grand Forks contributed 125,000 P.E. to the river. Because of the unusually high stream flows and atmospheric reaeration replenishing the oxygen supply, the effect of the waste discharges on the D.O. gradient was

Table 8

Dissolved Oxygen

Red River of the North Grand Forks to International Boundary

Station	River Mile	Dissolved Oxygen Sept. mg/l	Dissolved Oxygen Nov. mg/l	Dissolved Oxygen Jan. mg/l
RR-27	298	7.4	12.2	8.8
28	292	8.2	11.6	
29	286	8.2	11.1	
30	279	8.5	11.2	10.8
31	274	8.5	11.2	10.8
32	254	9.0	11.4	
34	236	8.8	11.6	10.4
36	208	8.9	11.8	10.2
37	176	9.4	11.7	
39	158	9.0	11.7	11.9

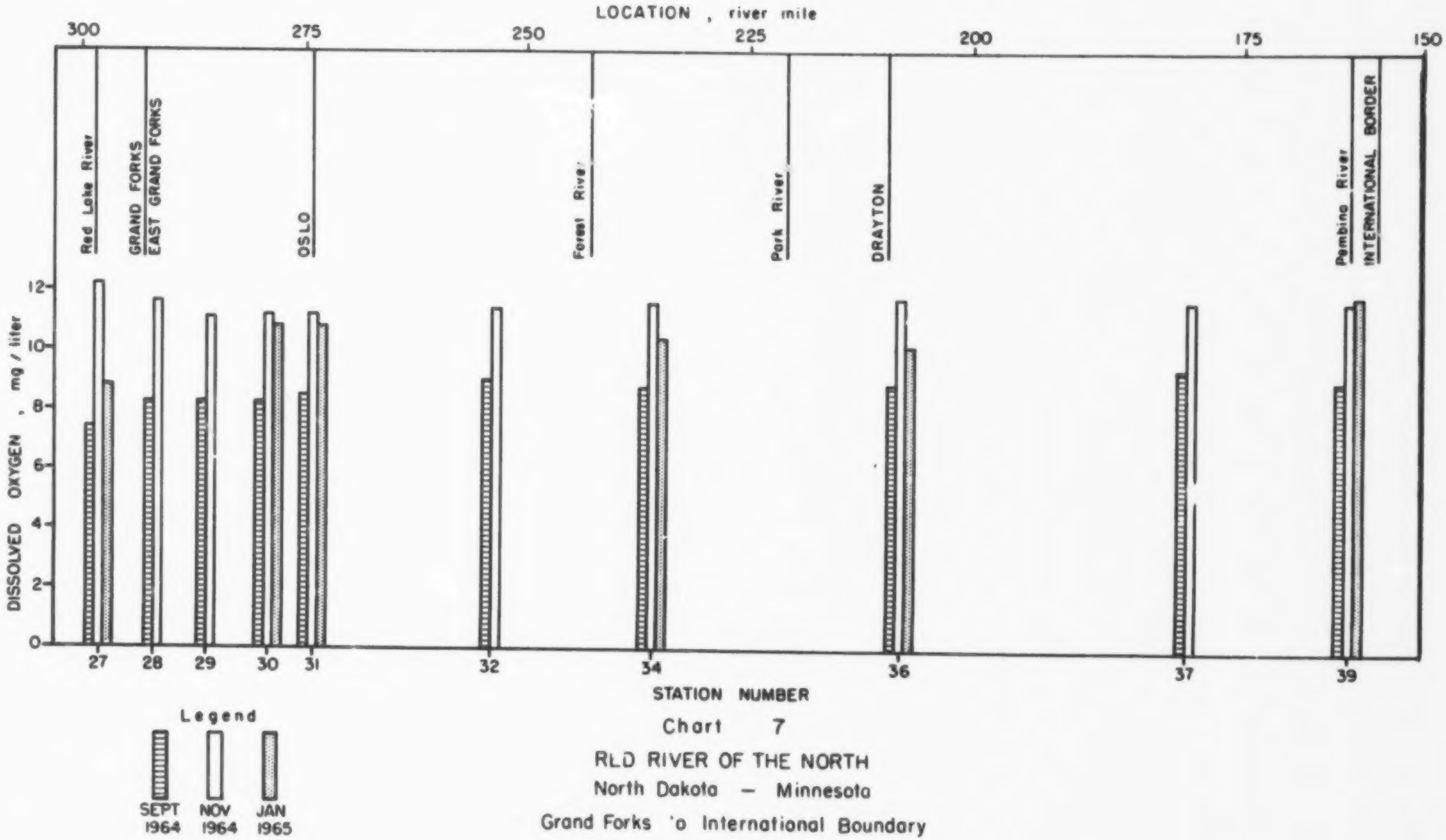


Chart 7

RLD RIVER OF THE NORTH

North Dakota – Minnesota

Grand Forks 'o International Boundary

DISSOLVED OXYGEN

minor. At the International Boundary during this period the B.O.D. was 3.5 mg/l and the D.O. was 11.7 mg/l.

In January, potato wastes were being discharged intermittently in the Grand Forks area. The D.O. at R.M. 298 was 8.8 mg/l, which reflected the very low D.O. in the Red River above Grand Forks. The D.O. was increased to 10.8 mg/l by aeration over the dam at Grand Forks and remained fairly constant to the International Border. When the river crossed the Border under ice cover, the D.O. was 11.9 mg/l. The B.O.D. during January averaged 1.5 mg/l, which is about the level normally found in unpolluted waters. Under present conditions, there appears to be no oxygen depletion problem under ice cover in the reach from Grand Forks-East Grand Forks to the International Boundary.

BACTERIA

Waste effluents contain enormous numbers of bacteria, among which there are usually pathogenic organisms that can cause gastrointestinal diseases such as typhoid fever and diarrhea. These pathogenic bacteria can cause illness in persons who swallow water containing them. As the densities of pathogenic bacteria are reduced or eliminated through waste treatment and disinfection, the hazards of contracting disease are proportionately reduced or eliminated. Methods for the detection of these pathogenes have, up to now, been too complicated for practical use in field determination. However, a more refined method of detection which has recently become available now makes possible the isolation of Salmonella genus, one of the most common pathogenes infecting man, in a relatively easy and convenient manner. This analysis was performed at certain locations during each phase of this survey.

Waste effluents contain bacteria of the coliform group which typically occur in excreta or feces and can readily be detected. These bacteria, usually harmless in themselves, are always present in river water which receives some form of waste and have, therefore, been used as an indication of the probable presence of pathogenic organisms. The possibility of pathogenic organisms being present in the absence of coliform organisms is extremely remote. The coliform group has been used by numerous state and interstate water pollution control agencies as a basis for water quality objectives for various water uses. These standards are based on total coliform densities and objections to their use have been based primarily on the fact that certain coliform species may be derived from sources other than excreta. Recently, a method for specific detection of fecal coliform bacteria has been developed. The U. S. Public Health Service drinking water standards to which both States subscribe say in a discussion of the sanitary significance of fecal coliform that: "Fecal coliform organisms may be considered indicators of recent fecal pollution. No satisfactory method is currently available for differentiating fecal coliform organisms of human and animal origin. Therefore, it is necessary to consider all fecal coliform organisms as indicative of dangerous contamination." Both total and fecal coliform densities were determined on all samples. The results of both determinations are expressed in most probable numbers or MPN, per 100 milliliters (ml) of water. The mean values used in this report are geometric averages.

Both States involved have adopted the Public Health Service recommended standard for quality of a raw water to be used as a source of water supply. This standard states that the total coliform density in no more than 20 percent of the samples examined in any month may be greater than 5000/100 ml, and no more than 5 percent of the samples examined in any month may be greater than 20,000/100 ml. In areas which are not used as a source of water supply, the States subscribe to a standard of 5000/100 ml mean coliform density.

COLIFORM BACTERIA

Ottertail River and Upper Red River

The mean values for this stretch are summarized in Table 9 and illustrated in Chart 8. The only large contributor of bacteriological pollution to the Ottertail is the discharge from the sewage treatment plant at Fergus Falls, Minnesota. This effluent causes an increase in mean total coliform density in the river from 210/100 ml to 16,200/100 ml, and in fecal coliform density from 24/100 ml to 4,760/100 ml. The Ottertail is impounded below Fergus Falls by the Orwell flood control dam, where dilution and dieoff reduce the bacterial densities appreciably. The highest value observed below Fergus Falls and above Orwell Dam was 160,000/100 ml for total coliforms and 54,000/100 ml for fecal coliforms. At the mouth of the Ottertail River the average density of total coliforms was 4,820/100 ml and 610/100 ml for fecal coliforms. Densities were as high as 54,000/100 ml for total coliforms and 7,900/100 ml for fecal coliforms at this point. It is apparent that the waters which are used by the cities of Wahpeton and Breckinridge for municipal supply should be limited as a source of water supply because of the health hazard involved, unless steps are taken to reduce the coliform densities.

High values of both total and fecal coliforms occurred on the Bois de Sioux River with concentrations of total coliforms as high as 160,000/100 ml. This pollution is the result of the discharge of untreated sewage from Fairmount, North Dakota.

In the interstate waters of Red River, total densities were

Table 9

Coliform Bacteria
Ottertail River and Upper Red River
September 1964

Station	River Mile	Coliform Densities (MPN/100 ml) Total	Fecal
Ottertail River			
OT-40	549-59	210	24
OT-41	549-42	16,200	4,760
OT-2	549-20	1,200	177
OT-3	549-2	4,820	610
Upper Red River			
RR-4	536	4,170	300
RR-5	501	3,920	400
RR-6	483	1,160	43
RR-7	472	4,700	131
Tributaries			
BD-1	549-9	2,800	540
WD-8	468-2	2,960	295

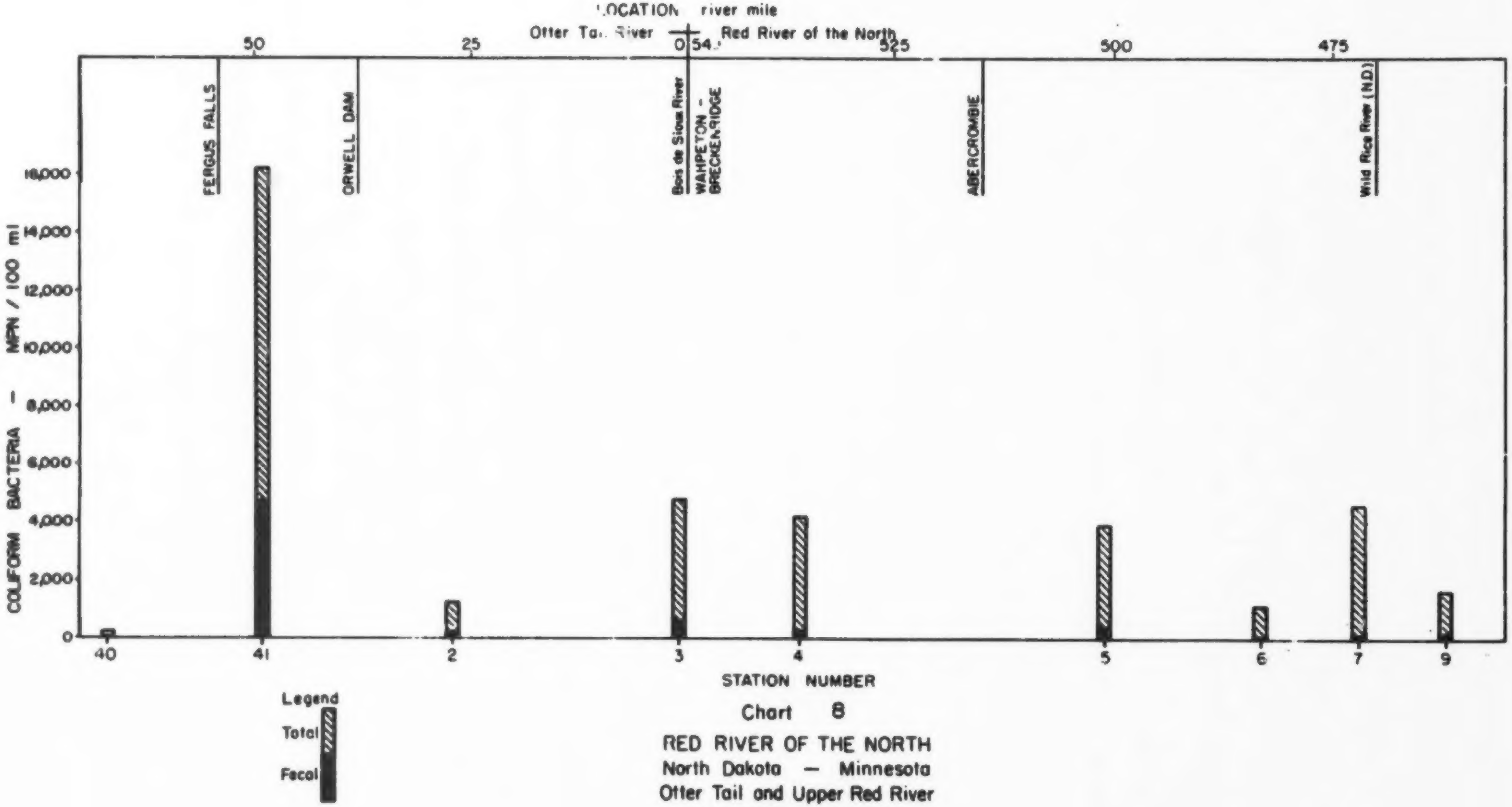


Chart 8

RED RIVER OF THE NORTH
North Dakota — Minnesota
Otter Tail and Upper Red River
COLIFORM BACTERIA

within the 5000/100 ml limit for coliforms for the reach between Wahpeton-Breckinridge and Fargo-Moorhead. The lowering of the waste stabilization pond at Wahpeton, North Dakota, did not appreciably affect the coliform densities in the river. In the impoundment at Fargo and close to the water supply intake for Fargo, the total coliform count was 1730/100 ml with a maximum density of 4600/100 ml and the fecal count was 236/100 ml with maximum value of 1400/100 ml. Since waste loads do not vary appreciably in this reach, sampling was limited to the September phase of the study.

Red River of the North - Fargo to Grand Forks

The mean values for this stretch are summarized in Table 10 and illustrated in Chart 9. The major sources of bacteriological contamination in this stretch of river are the unchlorinated effluents from the two secondary sewage treatment plants at Fargo and Moorhead and the discharge from the beet sugar processing plant at Moorhead when it is in operation.

During September, with the sugar plant not operating, the combined discharges from the municipal treatment plants produced a mean coliform density in the river below Fargo-Moorhead at R.M. 441 of 865,000/100 ml total coliforms, with a minimum value of 79,000/100 ml and a mean density of 233,000/100 ml of fecal coliforms with a minimum of 33,000/100 ml. Values as high as 2,800,000/100 ml of total and 790,000/100 ml of fecal coliforms were obtained at this sampling point. The coliform densities were reduced quite rapidly downstream to Hendrum, R. M. 386, where they were approximately at the same level as that

Table 10

Coliform Bacteria
Red River of the North
Fargo to Grand Forks

Station	River Mile	Coliform Densities (MPN/100 ml)					
		Sept.		Nov.		Jan.	
		Total	Fecal	Total	Fecal	Total	Fecal
RR-9	462	1,730	236	314	49	530	450
RR-10	441	865,000	233,000	432,000	155,000	162,000	61,000
RR-11	436	250,000	64,500	249,000	85,600	83,500	34,000
RR-12	426	47,600	2,850	68,000	16,800		
RR-14	416	16,800	1,510	27,100	8,160	18,600	9,170
RR-15	403	4,590	500	20,300	5,310	19,100	10,800
RR-16	386	990	126	6,630	1,610	7,800	5,160
RR-18	375	1,970	117	4,180	722	6,140	2,950
RR-19	357	2,200	26	2,650	780	9,900	3,930
RR-20	347	1,260	23	1,130	250	3,520	1,970
RR-21	335	13,300	82	1,410	247	4,760	2,600
RR-22	319	710	43	125	20	1,600	820
RR-23	305	1,160	55	48	20	1,280	590
G. F. Water Intake	300					1,100	340
SH-13	428-1	68,000	1,530	1,410	203	650	218
WM-17	380-3	12,450	4,550	3,670	1,820	10,800 *	3,780

* Large numbers of ice fishing shanties were observed on the river at this sampling location.

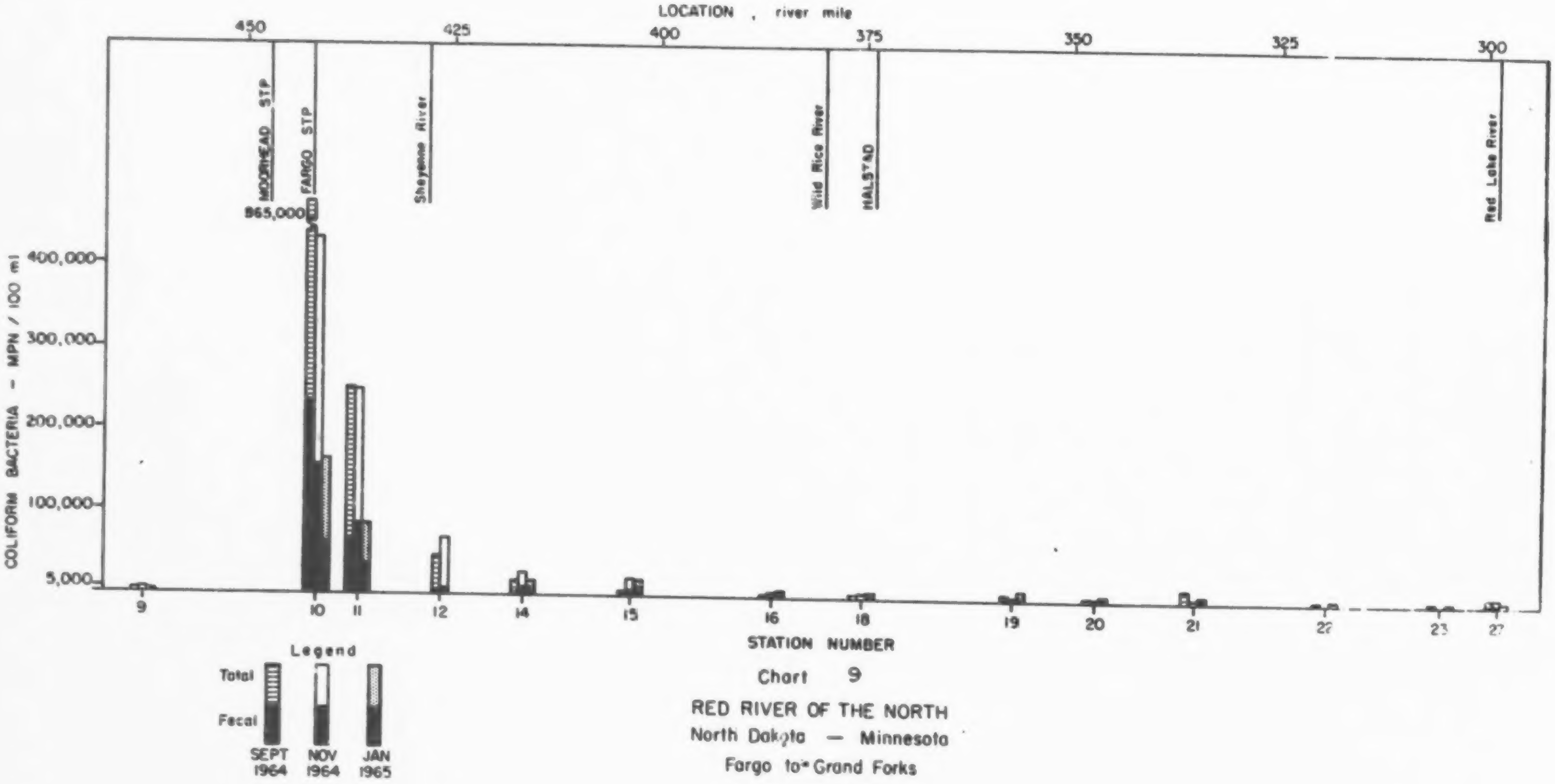


Chart 9

RED RIVER OF THE NORTH
North Dakota — Minnesota
Fargo to Grand Forks
COLIFORM BACTERIA

upstream of sewage discharges. The Sheyenne River contributed a large quantity of coliform bacteria (68,000/100 ml) to the Red River but the fecal coliform density was relatively low (1,530/100 ml) indicating that most of the pollution was probably not from human or animal origin. The Wild Rice River in Minnesota contributed a comparatively high coliform density, which was reflected in the total coliforms in the Red River but not in the fecal coliforms. Concentrations remained low throughout the remainder of the stretch except for a mean of 13,300/100 ml in total coliforms at R.M. 335 near Climax, Minnesota. The mean at this station was high because of several extreme values produced by a localized rainstorm and, since the fecal coliform density did not increase appreciably, may be considered to be due to land runoff from the storm.

During November, 1964, with stream flow about three times that in September, the mean coliform density increased from 314/100 ml to 432,000/100 ml from above Fargo-Moorhead to below the sources of waste. The corresponding values for fecal coliform densities were from 49/100 ml to 155,000/100 ml. Although the densities in November were less than those in September, with the higher stream flow in November the total numbers of coliforms were greater in November than in September, and total numbers of fecal coliforms were about twice as great. The only source of bacteria during November other than sewage from Moorhead and Fargo was the beet sugar plant waste at Moorhead. The effluent from this plant had total coliform densities of 940,000/100 ml and fecal coliform densities of 797,000/100 ml. The sugar plant discharge, therefore, contributed large densities of bacterial pollution. The bacteria decreased slowly in November and the total coliform densities remained above the standard for more than 100 river miles downstream from the waste sources. The densities were higher than the level observed above the waste discharges for nearly 130 miles downstream. The Sheyenne and Wild Rice rivers had comparatively low total and fecal coliform densities during this period. The total and fecal coliform densities in the impoundment immediately above Grand Forks were negligible.

In January, the same waste discharge conditions as in September prevailed except for a short period when the sugar beet plant was releasing wastes from a clean-up operation. The total coliform density in the river increased from 530/100 ml to 162,000/100 ml. Both total and fecal coliforms persisted longer in January, with its colder temperatures, than in November. The coliform densities in January at Halstad, Minnesota, were measurably higher and fecal coliforms were four times greater than in November. Data in Table 10 illustrate this observation. Coliform densities in January, under ice cover, were higher in the impoundment immediately above Grand Forks than they were during any other time of sampling. At the Grand Forks water intake, the mean total coliform density was 1100/100 ml with values as high as 4900/100 ml.

Red Lake River - Crookston to Grand Forks

The mean bacterial densities observed in this stretch are summarized in Table 11 and illustrated in Chart 10. During most of the year there was no discharge of waste to this stretch of the Red Lake River. In September, sewage was discharged from the municipal waste stabilization pond in Crookston to lower the pond level in preparation

Table 11

Coliform Bacteria
Red Lake River
Crookston to Grand Forks

Station	River Mile	Coliform Densities (MPN/100 ml)					
		Sept.		Nov.		Jan.	
		Total	Fecal	Total	Fecal	Total	Fecal
RL-24	298-66	918	35	3,040	670		
RL-43	298-46			58,900	11,200		
RL-25	298-28	27,300	248	29,500	6,940		
RL-42	298-14			31,000	6,850		
RL-26	298-0	6,570	28	9,200	1,120	4,500	1,560

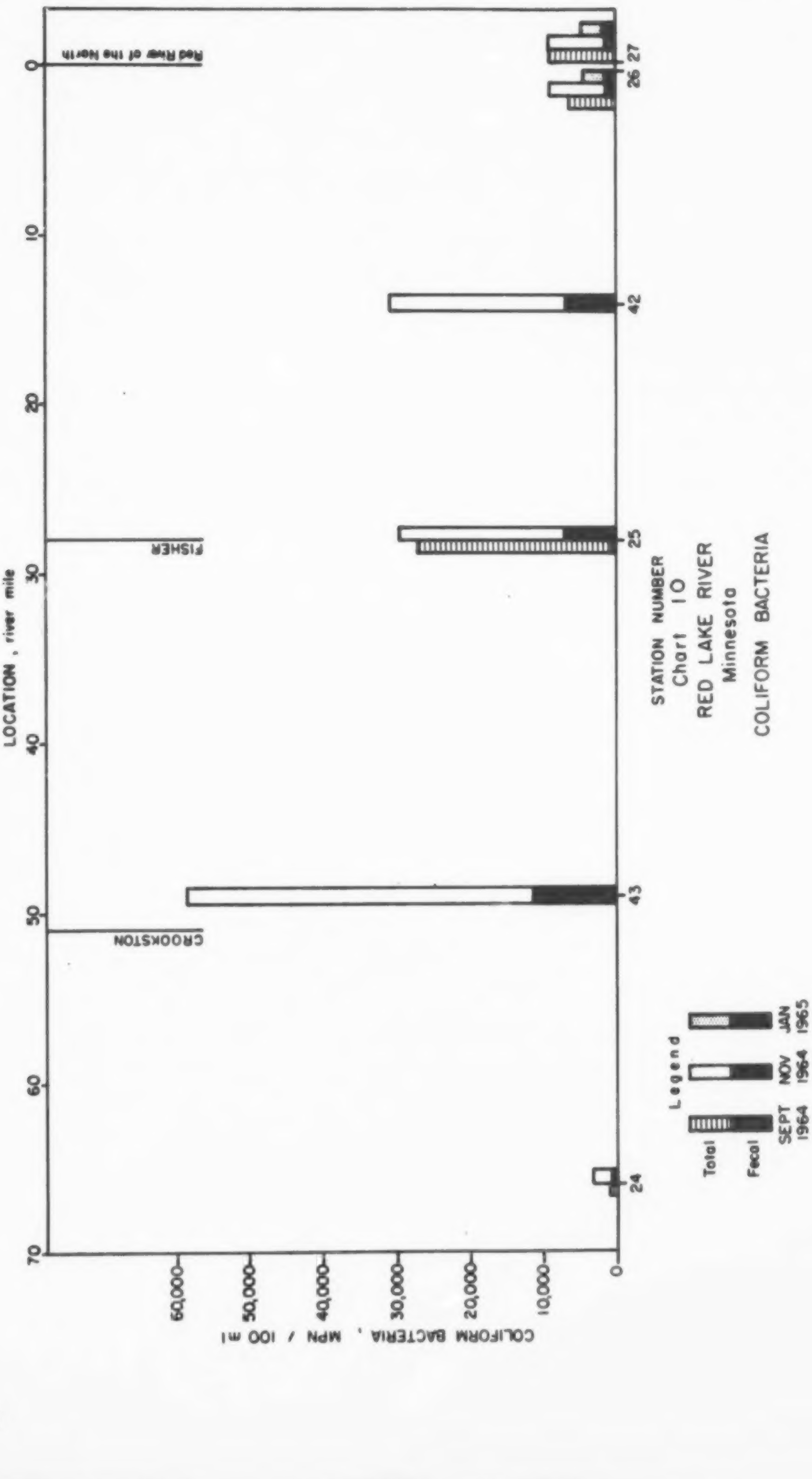


Chart 10
RED LAKE RIVER
Minnesota
COLIFORM BACTERIA

for winter storage. Although the waste discharge from the pond had been held for months, the total coliform content was sufficient to increase the density in the river about 27 times from above the outfall to below it. Total coliform density increased from 918/100 ml above the outfall to 27,300/100 ml below the waste discharge. The fecal coliform density of this waste was quite low, however, causing an increase from 35/100 ml to 248/100 ml in the river. At East Grand Forks the fecal coliform count of 28/100 ml was approximately the same level as that upstream of the pond discharge. The total coliform density of 6570/100 ml was above the State requirements for a water supply. Grand Forks and East Grand Forks have water intakes in the Red Lake River below the waste stabilization pond discharge at Crookston.

In November, with the American Crystal Sugar Company plant at Crookston discharging wastes to the river, the total coliform density increased from 3040/100 ml to 58,900/100 ml, and the fecal coliform density from 670/100 ml to 11,200/100 ml. These represent total bacterial numbers about five times that of September for total coliforms and 93 times greater for fecal coliforms. The sugar plant was the only additional source of waste. The waste effluent from this plant had a mean total coliform density of 6,360,000/100 ml and a fecal coliform density of 1,400,000/100 ml. At East Grand Forks, the total coliform number in November was six times the September value. The total coliform density at East Grand Forks during this phase was 9,200/100 ml and fecal coliform density was 1,120/100 ml. These densities are well in excess of the recommended standard of the States.

During January there were no waste discharges to the Red Lake

River. The total coliform density was in excess of the States' standards for a source of water supply. The fecal coliform density at the monitoring station in East Grand Forks was 1120/100 ml. It is presumed that the extremely low temperatures and the demonstrated persistence of fecal coliform under low temperatures account for this finding, but the source could not be ascertained.

Red River of the North - Grand Forks to International Boundary

The mean bacterial densities observed in this stretch are summarized in Table 12 and also are illustrated in Chart 11. In September the wastes from the municipal waste stabilization ponds at Grand Forks and East Grand Forks were being discharged to the river at R.M. 294. This caused an increase in total coliform density in the Red River from 9050/100 ml to 56,500/100 ml but, as below Crookston, the increase in fecal coliform concentration was comparatively small; from 222/100 ml to 1160/100 ml. Fecal coliforms decreased rapidly in September and at R.M. 236, 58 miles downstream, the mean value was 39/100 ml. The total coliforms, however, remained fairly constant, indicating extensive land runoff. This conclusion is supported by the steadily increasing river flow downstream in this stretch.

The Red River is used as a source of water supply by Oslo, Minnesota, and the densities in the river at this point were 22,800/100 ml and 332/100 ml for total and fecal coliforms respectively. The discharge of untreated sewage at Drayton caused an increase in the fecal coliform density from 39/100 ml to 298/100 ml. Drayton will have a waste stabilization pond system in operation in the near future

Table 12

Coliform Bacteria
Red River of the North
Grand Forks to International Boundary

Station	River Mile	Coliform Densities (MPN/100 ml)					
		Sept.		Nov.		Jan.	
		Total	Fecal	Total	Fecal	Total	Fecal
RR-27	298	9,050	222	9,160	1,440	4,870	1,900
RR-28	292	56,500	1,160	39,800	2,970		
RR-29	286	35,600	890	27,800	1,030		
RR-30	279	23,000	312	21,900	606	17,000	3,700
RR-31	274	22,800	332	19,000	1,100	25,200	2,400
RR-32	254	22,800	51	11,200	195		
RR-34	236	24,400	39	13,100	189	8,850	820
RR-36	208	15,900	298	6,170	476	8,910	800
RR-37	176	2,900	35	3,500	56		
RR-39	158	914	25	2,520	27	4,800	540
FR-33	243-7	4,350	183	1,730	87		
PR-35	222-5	3,870	221	501	70		
PE-38	158-0.5	9,850	400	561	40	3,200	1,000

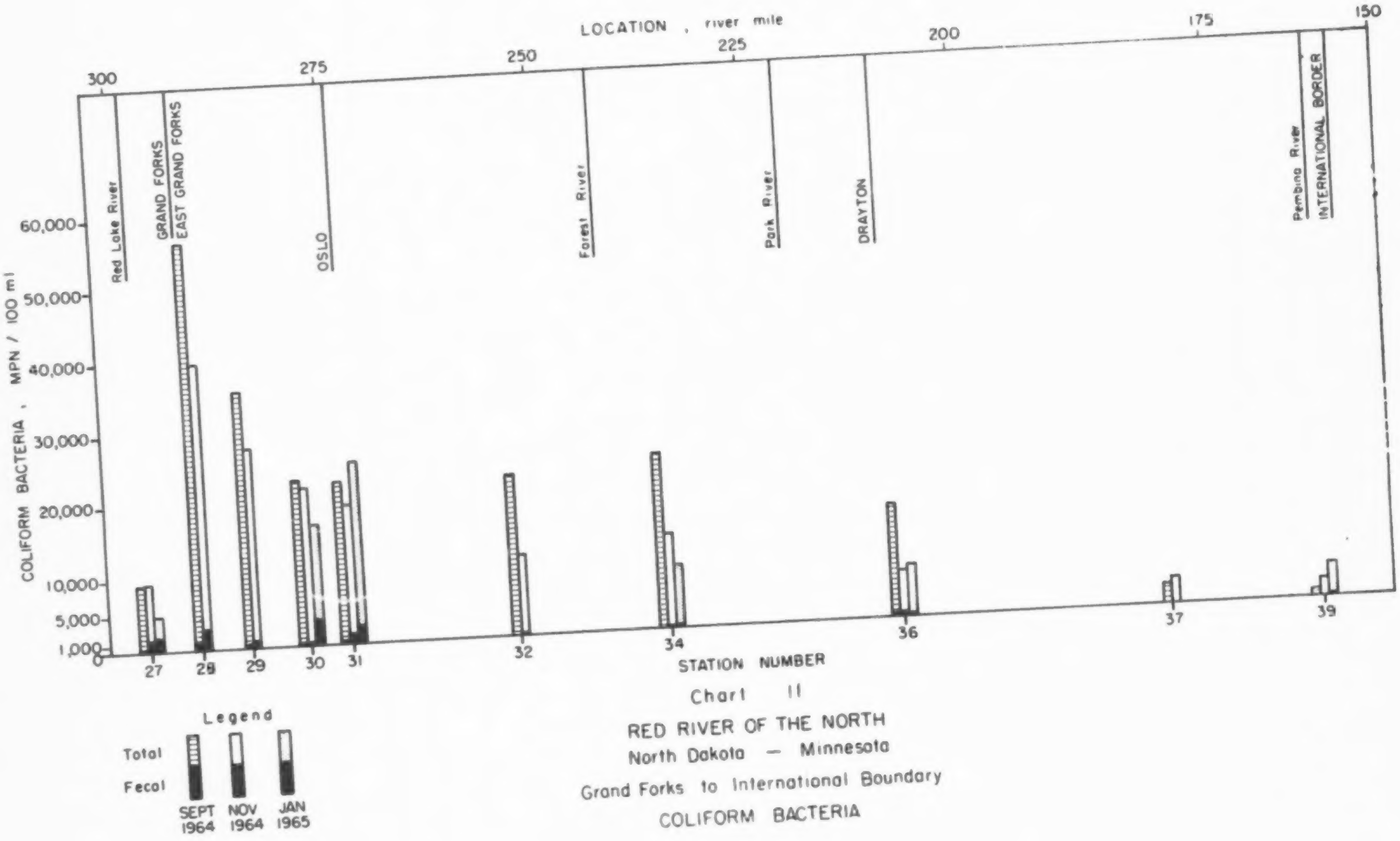


Chart 11

RED RIVER OF THE NORTH

North Dakota — Minnesota

Grand Forks to International Boundary

COLIFORM BACTERIA

so this source will be eliminated. The total and fecal coliforms decreased rapidly below Drayton and laboratory bacterial survival tests of Red River water at Pembina showed that some undetermined constituent of the water inhibited the growth of coliforms. The densities of total and fecal coliforms just before crossing the International Boundary were 914/100 ml and 24/100 ml respectively.

During November, the American Crystal Sugar Company at East Grand Forks and the Rogers Brothers and Pillsbury potato plants in Grand Forks were discharging wastes to the river. In addition, some waste was entering the river from the North Dakota State Mill and a few other commercial establishments connected to this sewer. The municipal waste stabilization ponds also were being discharged. The total coliforms count rose from 9160/100 ml to 39,800/100 ml and the fecal coliforms from 1440/100 ml to 2970/100 ml. The river flow was about two and one-half times that of September, and this represents an increase in total numbers of bacteria in the river of about one and one-half times that of total coliforms and about four times that of fecal coliforms in September. Bacteriological data from each of the industries disclosed that in the wastes from the sugar plant the total and fecal means were 9420/100 ml and 646/100 ml respectively. These are far below the results obtained from the other two sugar plants. This plant provides from seven to eleven days' storage to the wastes before discharge. The corresponding low coliform densities in comparison with the other two sugar plants show the effectiveness of storage in reducing coliform densities. The Pillsbury potato plant uses a lye peeling process which effectively reduces the bacterial contribution to a negligible quantity due to causticity of the lye. The waste from the Rogers Bros. plant had 56,300,000/100 ml and 609,000/100 ml densities for total and fecal coliforms and from the State Mill the densities for total and fecal coliforms were 4,840,000/100 ml and 534,000/100 ml. The wastes from the State Mill sewer are to be connected to the Grand Forks city system in the near future. The largest single contribution of bacterial pollution at Grand Forks was the Rogers Bros. potato plant. It has been agreed that the wastes from the potato plants will be discharged to the Grand Forks municipal system after primary treatment and will be impounded in the municipal lagoons. At Oslo, the densities during this period were 19,000/100 ml and 1100/100 ml respectively. Inflow from the tributary Park and Forest rivers during this period was minor and the fecal coliforms were negligible. At the International Boundary, the densities were 2520/100 ml for total coliforms and 27/100 ml for fecal coliforms.

During January, there was an increase in total coliform density from 4870/100 ml to 17,000/100 ml from above to below sources of waste at Grand Forks-East Grand Forks. The potato plants, during this time, were discharging wastes intermittently as production varied, depending on the supply of potatoes. The State Mill sewer was discharging regularly and the beet sugar plant was not discharging. As in the other stretches of river, the coliform organisms survived for long periods of time under ice cover. At Oslo, the total and fecal coliform averages were the highest of any of the three sampling periods, with values of 25,200/100 ml and 2400/100 ml respectively. At the International Boundary, the total coliform density was 3200/100 ml and the fecal coliform density was 1000/100 ml.

In this stretch of the river, the bacteria at the Oslo water supply intake exceeded the standard for total coliforms during all phases of the survey. The densities of total coliform also exceeded the standard for more than 100 miles downstream from Grand Forks-East Grand Forks under open water conditions. During January, the coliform densities exceeded the standard from Grand Forks to Drayton. Drayton also uses the river as a source of water supply.

PATHOGENIC BACTERIA

Infectious diseases are produced by certain viruses or bacteria and these causative agents are known as pathogenes. It has been an accepted procedure in public health practice to describe deleterious bacteriological quality of water by means of coliform density on the basis that these organisms are indicators of the potential presence of pathogenes. Although the coliform genus is not normally considered pathogenic in itself, fecal coliform bacteria indicate the presence of intestinal or fecal matter which may be a source of intestinal disease-producing organisms or enteric pathogenes. It would, therefore, be appropriate to isolate the disease producers directly wherever possible. If it can be demonstrated that pathogenic micro-organisms are indeed present in comparison with the observed coliform bacteria, both total and fecal, the importance and validity of the coliform group as indicators of pathogenes will be enhanced.

Salmonella, a genus with more than nine hundred species, most of which have been shown to be pathogenic to man and warm-blooded animals, commonly produce serious disease in man. One of the species can produce typhoid fever by ingestion of polluted water. In the past, the isolation of Salmonella from streams or natural waters was deemed impractical because of their relatively low concentrations compared to coliform densities. Now, however, because of the availability of new techniques as well as specific or selective media, the isolation of these pathogenes is possible even at relatively low coliform densities. The principal determination of bacterial pollution of the Red River of the North was based on examination for coliform bacteria. On this survey also, sampling was initiated in certain areas for the detection of pathogenes (Salmonella) and the results of these examinations are given in Table 13.

In September sampling was conducted for only a short distance below the municipal waste outfalls. Three determinations were made: immediately below the Moorhead sewage treatment plant outfall; 12 miles below the outfall at river mile 436, which is one-half day time of travel downstream; and at river mile 426, 22 miles below, or one day time of travel from the outfall. Positive results were obtained at all sampling points. In addition, the same species was identifiable below the outfall and at R. M. 436, 12 miles downstream, thereby implying a strong cause and effect relationship. Twenty-two miles downstream, where the fecal coliform density was a relatively low 2850/100 ml, Salmonella organisms were isolated, indicating persistence even when coliform values are low.

In November, the pathogen sampling program was greatly enlarged and extended. Salmonella were isolated at every sampling point below the sources of waste at Fargo and Moorhead. Significantly, no pathogenic colonies were isolated at a sampling point above the waste

Table 13

Salmonella Organisms

Red River of the North

Date	Station	River Mile	Distance from Waste Source (Miles)	Flow Time (Days)	Total Coli/100ml	Fecal Coli/100ml	Salmonella
Sept. 1964	Moorhead Sewage Treatment Plant	448	0		Not Done	Not Done	S. kentucky
	RR 11	436	12	0.5	250,000	64,500	S. kentucky
	RR 12	426	22	1.0	47,600	2,850	S. saint paul
Nov.1964	RR 9	462	-14		314	49	Absent
	RR 10	441	7	.3	432,000	155,000	S. typhimurium
							S. braenderup
							S. reading
	RR 11	436	12	.4	249,000	85,600	S. braenderup
							S. heidelberg
							S. reading
	RR 12	426	22	.8	68,000	16,800	S. blockley
							S. braenderup
	RR 16	386	62	3.0	6,630	1,610	S. heidelberg
	RR 28	292	7	.3	39,800	2,970	S. reading
	RR 29	286	13	.7	27,800	1,030	S. reading
							S. infantis

Table 13
(Contd.)

Date	Station	River Mile	Distance from Waste Source (Miles)	Flow Time (Days)	Total Coli/100ml	Fecal Coli/100 ml	Salmonella
Jan. 1965	RR 10	441	7	.2	162,000	61,000	S. chester
							S. thompson
							S. oranienburg
							S. st. paul
	RR 11	436	12	.4	83,500	34,000	S. chester
							S. heidelburg
							S. st. paul
							S. enteritidis
							S. typhimurium
	SH 13	428-1	-	-	650	218	Absent
	RR 14	416	32	1.2	18,600	9,170	S. enteritidis
							S. chester
							S. st. paul
							S. thompson
	RR 16	386	62	3.3	7,800	5,160	S. st. paul
							S. enteritidis
							S. thompson
	RR 18	375	73	4.0	6,140	2,950	S. st. paul
							S. thompson

effluents. Most striking is that, at a distance of 62 river miles and over three days time of travel downstream from the sources of waste at Fargo and Moorhead, *Salmonella* were still present at a fecal count of 1610/100 ml. Colonies were also isolated below the industrial waste discharges at Grand Forks and East Grand Forks. The potato processing plants in Grand Forks discharge domestic sewage to the river. In both river reaches, the same species was found, for several miles dowstream, giving presumptive evidence that their source was the waste discharges.

In January, sampling was conducted under an ice cover averaging two and one-half feet. During this period, *Salmonella* colonies were isolated 73 river miles downstream and four days time of travel from Fargo-Moorhead under extremely cold river temperature conditions. *Salmonella st. paul* were isolated at every station below the waste discharges from the municipal plants. The major tributary to the Red River in this stretch, the Sheyenne River, did not yield any pathogenic colonies. Therefore, the origin of pathogenes as far removed downstream as Halstad, Minnesota, is the waste discharges at Fargo and Moorhead.

The 1964 report of the Salmonella Surveillance Committee of the U. S. Public Health Service ranks six of the most frequent *Salmonella* species infecting man and animals in the U. S. in 1963 (see Table 14). Four of the species isolated from the Red River of the North are among these top six for human infection. They are *S. typhimurium*, *S. heidelburg*, *S. infantis*, and *S. enteritidis*, which rank one, three, five and six, respectively.

The attempt to isolate *Salmonella* during each of the three

Table 14

Salmonella Types Most Frequently Infecting Man and Animals in 1963

Rank	United States 1963 (1)	
	Man	Animal
1	S. typhimurium	S. typhimurium
2	S. derby	S. heidelberg
3	S. heidelberg	S. infantis
4	S. newport	S. anatum
5	S. infantis	S. montevideo
6	S. enteritidis	S. newport

(1) Source: CDC Salmonella Surveillance Report No. 21, Feb. 3, 1964.

phases of the Red River of the North survey resulted in a 100 percent recovery of these pathogenes wherever they were reasonably expected to be found. *Salmonella* were not recovered upstream from the principal sources of pollution. Colonies were recovered at all points sampled below the sources of wastes and their extreme persistence is shown by isolation 73 miles and four days time of travel downstream from the Fargo-Moorhead outfalls under ice cover. Four of the *Salmonella* species isolated from the Red River of the North are among the top six most frequently infecting man in the United States in 1963.

BIOLOGY

AQUATIC LIFE

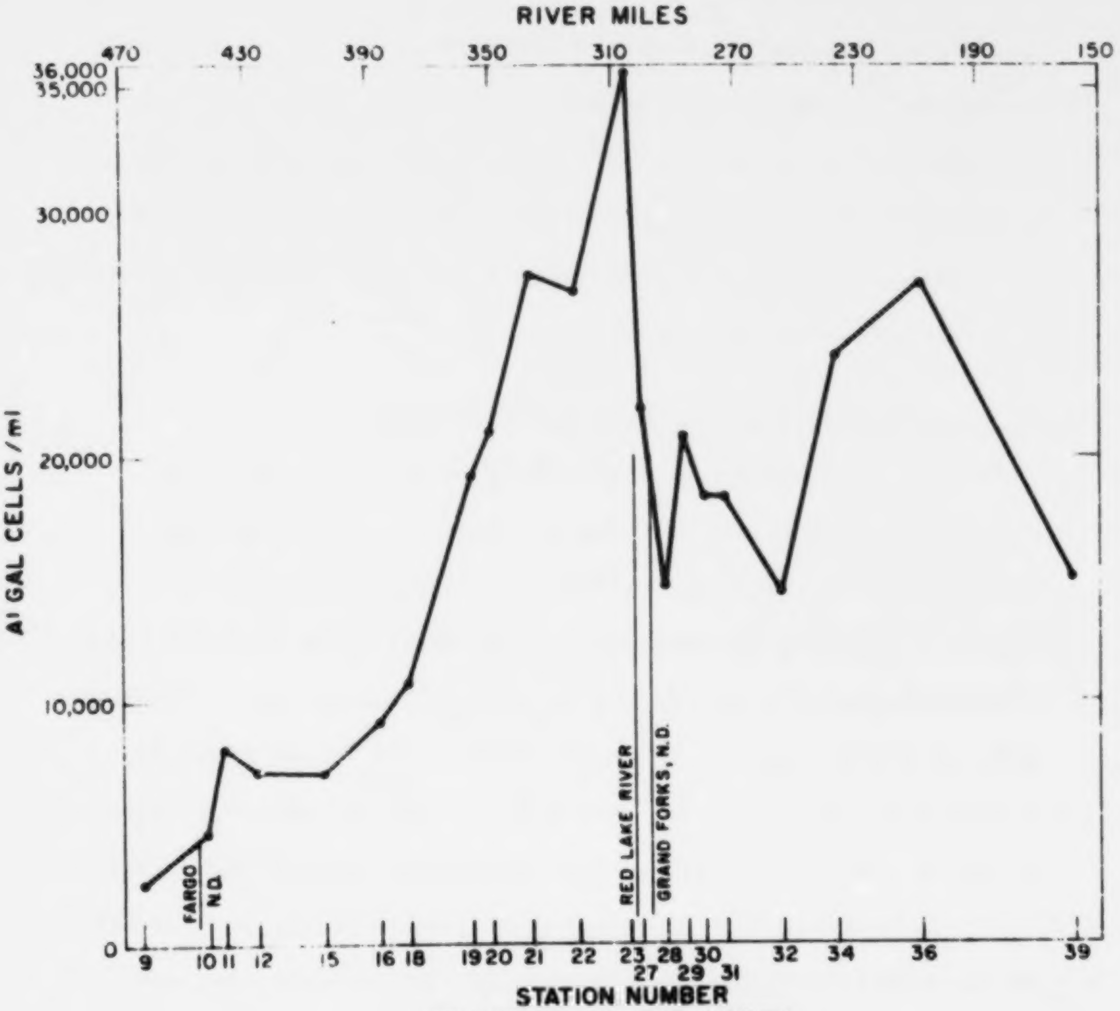
The biological study of the Red River of the North measured the effects of wastes on the aquatic life. Bottom-associated organisms are best adapted to evaluate these effects because they have life cycles that are at least one year in length and thus tend to reflect conditions over a long period of time, and because most bottom organisms have limited methods of locomotion which restrict them to specific stream reaches. Thus, the group of bottom dwelling organisms, considered as a unit, are used to indicate the quality of water flowing over the stream bed. Experience has shown that water quality changes sufficient to alter the structure of the bottom dwelling group will also alter the fish population and other aquatic organisms. Reductions in sensitive bottom forms indicate that the fish population is likewise adversely affected.

Unpolluted water supports a diverse population of bottom organisms and fish, but because of competition and predation, only a few of each kind are usually present. Two different changes occurred in the population of bottom-associated organisms as the result of organic wastes entering the Red River: (1) there was a reduction in the number of kinds of organisms, which resulted from the unnatural covering and blanketing of rocks and the river bottom, by settleable solids and by slime growths produced by the waste discharges, and (2) there was an increase in the numbers of the remaining bottom-associated organisms that resulted from an increased food supply. Three surveys were conducted to evaluate the effect of wastes under different seasonal conditions.

Fargo, North Dakota to Grand Forks, North Dakota

Upstream from Fargo, North Dakota (R.R. 9), the Red River supported five kinds of pollution-sensitive fish food organisms, such as sprawling mayflies, burrowing mayflies, and caddisflies (Appendix). During the September survey, wastes from the Fargo, North Dakota, and the Moorhead, Minnesota, sewage treatment plants eliminated these sensitive organisms for seven miles except for an occasional sprawling mayfly (Chart 13). The kinds of pollution-tolerant organisms increased from two upstream to four downstream from the waste sources.

In November, the combined wastes from the Fargo, North Dakota, and Moorhead, Minnesota, sewage treatment plants and the Moorhead, Minnesota, sugar beet plant eliminated all pollution-sensitive bottom organisms for 17 miles and provided food that increased the pollution-tolerant sludgeworms from 8 to 1,116 per square foot, 17 miles downstream from the waste source (Appendix). No game fish were found to inhabit the reach of river 17 miles downstream from the waste sources in Fargo, North Dakota, area; however, game fish such as northern pike and channel catfish were collected by electro-shocking upstream from Fargo, North Dakota. The absence of sensitive bottom organisms



RED RIVER OF THE NORTH
NORTH DAKOTA — MINNESOTA

TOTAL PHYTOPLANKTON

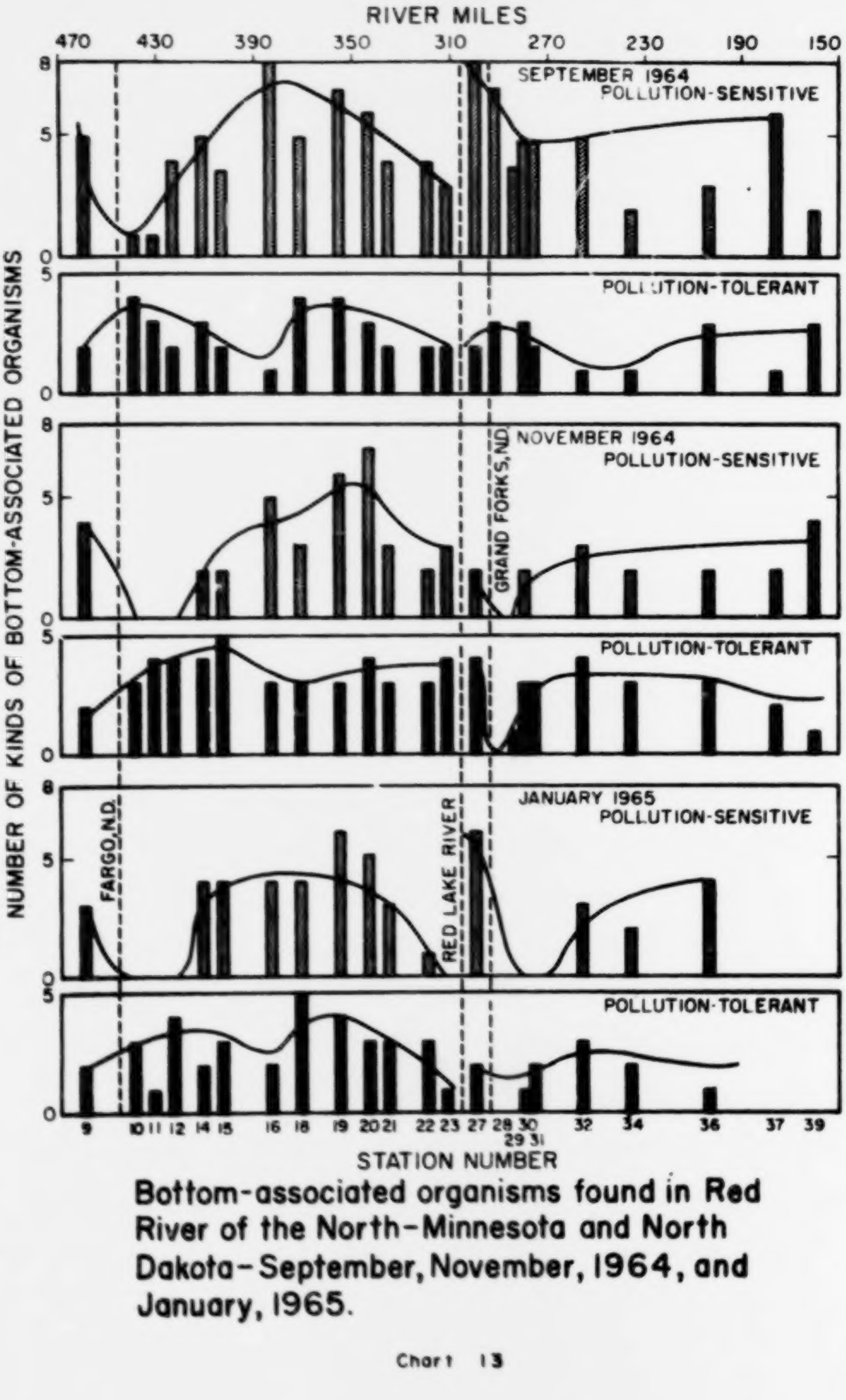
NOVEMBER 1964

Chart 12

and game fish gives vivid testimony to the polluted conditions of the waters in this reach.

Sugar beet wastes reduced the kinds of sensitive organisms from seven in September to two in November in the reach downstream from the confluence of the Sheyenne River with the Red River. Of the two remaining sensitive forms, caddisflies numbered 605 per square foot. This unusually dense population was the result of increased nutrients that provided a ready food supply. These nutrients were from the Fargo-Moorhead area. In addition, organic wastes from the Moorhead, Minnesota, sugar beet plant also increased the population of pollution-tolerant sludgeworms from 2 per square foot in September to 598 per square foot in November, 40 miles downstream from the waste source. The combination of various forms of carbonaceous and nitrogenous material contained in the wastes from the wastes from the Moorhead, Minnesota, sugar beet plant and the Fargo, North Dakota, and Moorhead, Minnesota, sewage treatment plants provided nutrients for the growth of bacterial slimes below Fargo-Moorhead to about Georgetown, Minnesota that covered the stream bed and sensitive fish food organisms, interfering with the normal life processes of the latter.

Under ice cover, sometime between November and January phases of the study, organic wastes that had been discharged by the Moorhead, Minnesota, sugar beet plant settled in a 20 mile slack water reach upstream from Grand Forks, North Dakota, and depleted the dissolved oxygen. This resulted in elimination of all pollution-sensitive mayflies. In November, 3 kinds of mayflies averaging 34 per square foot



Bottom-associated organisms found in Red River of the North–Minnesota and North Dakota–September, November, 1964, and January, 1965.

Chart 13

inhabited this area, but in January none were found.

Grand Forks, North Dakota - Canadian Border

During September, wastes from the Grand Forks, North Dakota sewage lagoons reduced the number of kinds of sensitive fish food organisms from eight upstream to seven two miles downstream from the discharge, and increased the tolerant forms from one to four. However, because of the decreased velocity which caused an increased effect of the discharged organic wastes, the sensitive forms were reduced to three kinds eight miles downstream from the lagoon discharge.

In November, the combined wastes from the Grand Forks, North Dakota, sewage lagoons, East Grand Forks, Minnesota, sugar beet plant, Grand Forks, North Dakota, potato factories, and the Crookston, Minnesota, sugar beet plant eliminated all bottom-associated organisms for at least two miles in the Red River. Six miles downstream from the waste sources only pollution-tolerant sludgeworms were found. Fifteen miles downstream from the waste sources no sensitive fish food organisms were observed, whereas, in September this reach supported five kinds of sensitive fish food organisms. At Oslo, Minnesota, pollution was still evident. Pollution-tolerant sludgeworms had increased from 8 per square foot in September to 608 per square foot in November, following industrial waste discharges. This high population of sludgeworms resulted from the increased organic materials discharged from the sugar and potato factories in the Grand Forks, North Dakota, area.

Bacterial slimes in November covered the stream bed and interfered with the normal life process of the sensitive fish food organisms for 15 miles downstream from the waste sources at Grand Forks, North Dakota.

January results indicated that the decomposition of the organic wastes made conditions so bad near Oslo, Minnesota, that all mayflies were eliminated sometime between November and January.

The phytoplankton (floating algal) populations in the Red River of the North are important because of the problems they create in drinking water supplies. In November, the phytoplankton populations near the Oslo, Minnesota, Drayton and Grand Forks, North Dakota, water treatment plants intakes contained a sufficient density of diatoms (Stephanodiscus hantzschii) to shorten filter runs. Populations of floating algae increased from 2,500 cells per ml upstream from Fargo, North Dakota (R.R. 9), to 35,650 cells per ml near the Grand Forks water intake (R.R. 23) (Chart 12). Upstream from Oslo, Minnesota (R.R. 30), and Drayton, North Dakota (R.R. 34), floating algal populations were 20,750 and 24,250 cells per ml, respectively. All populations contained at least 70 percent of the problem causing diatom. Filter clogging is compounded by the occurrence of mat-forming diatoms on which other organisms collect.

Taste and odor problems in municipal water supplies at Grand Forks, North Dakota, Oslo, Minnesota, and Drayton, North Dakota, probably are caused by the diatom, Stephanadiscus sp.

Nutrients principally responsible for the increased floating algae in the Red River during November between Fargo and Grand Forks, North Dakota, were contained in the wastes from the Fargo-Moorhead area. The Fargo, North Dakota and Moorhead, Minnesota sewage treatment plants in January increased the soluble phosphorus in the river from 0.10 to 0.57 mg per liter as P and the inorganic nitrogen (NH_3-N+NO_3-N +NO_2-N) from 0.8 to 1.8 mg per liter (as N) in the Red River downstream from the respective sources. This increase in concentration of nitrogen and phosphorus was sufficient to promote increased algal productivity during open water periods.

Crookston, Minnesota - Confluence of the Red Lake and Red Rivers

In September, the Red Lake River and the reach of the Red River downstream from the confluence of the Red Lake and Red rivers supported a diverse population of seven kinds of sensitive stoneflies, mayflies, and caddisflies.

Wastes from the Crookston sugar beet plant, in November, eliminated six of these kinds of sensitive fish food organisms from this 49 mile reach of the Red Lake River. These wastes destroyed the population of fish food organisms in both the Red Lake River and in the interstate Red River. In a two mile reach of the Red River just downstream from the confluence with the Red Lake River at Grand Forks, North Dakota, sensitive organisms were reduced to two kinds in November from seven in September by organic wastes and slimes resulting from waste discharges from the Crookston, Minnesota, sugar beet plant. The destruction of the fish food organism population inhabiting the Red River downstream from the waste discharges in Grand Forks-East Grand Forks resulted from combined wastes from Crookston, Minnesota, and the Grand Forks-East Grand Forks area.

Bacterial slimes resulting from the nutrients contained in the wastes from Crookston, Minnesota, blanketed both the stream bed and sensitive organisms in the Red Lake and Red rivers, and thus reduced the natural food for sport fishes.

SUMMARY AND CONCLUSIONS

UPPER RED RIVER AND OTTERTAIL RIVER

1. The densities of total coliforms at the mouth of the Ottertail River in September, 1964 exceeded the States' limits for a source of water supply. Four samples out of 11 or 36 percent exceeded 5000 coliform per 100 ml. Two of the 11 samples or 18 percent exceeded 20,000 coliform per 100 ml. The States require that not more than 20 percent exceed the 5000 limit, and not more than 5 percent exceed the 20,000 limit. The Ottertail is used by the cities of Wahpeton and Breckinridge for municipal water supply purposes.

2. Concentrations of total coliforms on the interstate waters of the Bois de Sioux River in September, 1964 were as high as 160,000/100 ml. This pollution is the result of the discharge of untreated sewage at Fairmount, North Dakota.

RED RIVER OF THE NORTH - FARGO TO GRAND FORKS

3. Sewage and industrial waste discharges in the State of Minnesota in this section of the river during this survey amounted to 80,680 population equivalents (P.E.) of which 62,000 P.E. were

the result of industrial waste discharges by the American Crystal Sugar Company at Moorhead, Minnesota. Sewage discharges from North Dakota amounted to 7,300 population equivalents. Of the total wastes contributed to the interstate waters of the Red River of the North in this section, 91 percent originates in the State of Minnesota and 9 percent in the State of North Dakota.

4. In September the discharge of treated sewage from the municipal plants at Fargo and Moorhead caused a reduction in D.O. of 4.5 mg/l in the Red River immediately below the sources of waste. The low mean concentration of 4.4 mg/l with individual values as low as 2.0 mg/l was below the standard of 5 mg/l.

5. The increased loading to the river caused by the discharge of wastes in November from the American Crystal Sugar Company plant at Moorhead reduced D.O. in the Red River to a low mean of 3.5 mg/l. Individual values of D.O. as low as 2.0 mg/l occurred. These low D.O. values are below the standard of 5 mg/l.

6. Under ice cover, the D.O. was reduced to 2.4 mg/l at the Grand Forks water intake by the waste discharges of the Fargo and Moorhead municipal treatment plants. The D.O. was completely depleted at the Grand Forks water intake when the American Crystal Sugar Company plant at Moorhead was discharging clean up wastes under the ice, in violation of the permit granted by the State of Minnesota.

7. Coliform densities in excess of 5000/100 ml occurred in the river in September, 1964 from the Fargo and Moorhead municipal waste sources to Perley, Minnesota, a distance of 43 river miles. Total

coliform means were as high as 865,000/100 ml and fecal coliform had a maximum mean of 233,000/100 ml. These excessive coliform densities are a health hazard to people using this water for purposes such as sport fishing. The gross coliform pollution in this area is the result of unchlorinated municipal sewage effluents at Fargo and Moorhead.

8. The discharge from the American Crystal Sugar Company plant at Moorhead contained densities of 940,000/100 ml for total coliforms and 797,000/100 ml for fecal coliforms in November, 1964. These wastes contributed to the total coliform density of 432,000/100 ml and fecal coliform density of 155,000/100 ml in the river. The municipal plants were also discharging during this period.

9. Total coliform density at the Grand Forks municipal water intake under ice cover amounted to 1,100/100 ml with values as high as 4,900/100 ml. This was a result of unchlorinated municipal waste discharges at Fargo and Moorhead.

10. Salmonella organisms which are pathogenic to man were detected below the sources of waste at Fargo and Moorhead during each phase of this survey and were shown to persist for 73 miles downstream from these sources. Four of the six species of Salmonella classified by the Public Health Service as most commonly infecting man in 1963 were isolated in the Red River of the North below the waste sources at Fargo and Moorhead.

11. The combined wastes from the Fargo and Moorhead municipal treatment plants and the American Crystal Sugar Company plant at

Moorhead reduced pollution-sensitive fish food organisms, produced slimes, and eliminated game fish for a distance of 40 miles in the Red River below the waste outfalls. The excessive increase in suspended algae, which was a result of these waste discharges, was of sufficient density to have caused taste and odor and filter clogging problems at the Grand Forks water plant. Under ice cover, low dissolved oxygen eliminated pollution-sensitive fish food organisms in a 20 mile reach of pool upstream from Grand Forks, 125 miles downstream from the waste sources.

RED LAKE RIVER - CROOKSTON TO GRAND FORKS

12. Discharge from the municipal waste stabilization pond at Crookston, Minnesota in September, 1964 caused bacterial pollution in the Red Lake River. The total coliform density in the Red Lake River at East Grand Forks was 6,570/100 ml. Both Grand Forks and East Grand Forks have water supply intakes in the Red Lake River.

13. The total coliform density of 9,200/100 ml in the Red Lake River at East Grand Forks in November, 1964 was caused by the discharge of wastes from the American Crystal Sugar Company plant at Crookston, Minnesota. The discharge from this plant had a mean total coliform density of 6,360,000/100 ml and a fecal coliform density of 1,400,000/100 ml. The municipal waste stabilization pond at Crookston was not discharging during this period.

14. Wastes from the American Crystal Sugar Company plant at Crookston, Minnesota reduced the population of fish food organisms

and produced slimes that blanketed the stream bed of the entire Red Lake River below the waste outfall and at least two miles of the Red River of the North in the Grand Forks area.

RED RIVER OF THE NORTH - GRAND FORKS TO INTERNATIONAL BOUNDARY

15. Sewage and industrial wastes discharged in the State of Minnesota to this section of the river amounted to 40,000 population equivalents. Sewage and industrial wastes discharged in North Dakota were equal to 105,610 population equivalents. Of the total wastes contributed to the interstate waters of the Red River of the North in this section, 28 percent originated in the State of Minnesota and 72 percent in the State of North Dakota.

16. Excessive bacterial pollution is contributed to the Red River of the North by the Rogers Brothers potato plant and the State Mill sewer in Grand Forks. The discharge from Rogers Brothers contained a total coliform density of 56,300,000/100 ml and a fecal coliform density of 609,000/100 ml. The State Mill sewer discharge contained total and fecal coliform densities of 4,840,000/100 ml and 534,000/100 ml respectively. These bacteria present a health hazard to persons using the waters to which they are discharged.

17. When the municipal waste stabilization ponds at Grand Forks and East Grand Forks were discharging, total coliform density increased in the river from 9,050/100 ml to 56,500/100 ml from above to below the outfalls.

18. During all phases of this study, the total coliform density at the Oslo, Minnesota water intake exceeded the States' standard for a source of water supply. Total coliform densities from 19,000/100 ml to 25,200/100 ml occurred at the Oslo water intake.

19. For conditions of open water, the mean total coliform densities at the International Boundary were less than 3,000/100 ml. Densities under the ice at the International Boundary were 4,800/100 ml for total coliforms and 540/100 ml for fecal coliforms.

20. Excessive concentrations of suspended solids were discharged from the potato plants in Grand Forks. The Pillsbury potato plant wastes had 4,840 mg/l and the Rogers Brothers wastes contained 7,500 mg/l. These suspended solids settle out in the stream and destroy bottom-associated organisms which serve as a food supply for fish. The suspended solids contribution from the potato plants at Grand Forks caused damage to the game fish population in the Red River of the North below the waste outfalls.

21. Salmonella organisms were observed for 10 miles downstream from the municipal and industrial waste discharges at Grand Forks-East Grand Forks in November, 1964. This was a result of wastes discharged in the Grand Forks-East Grand Forks area.

22. Wastes from the Grand Forks and East Grand Forks municipal waste stabilization ponds, the American Crystal Sugar Company plants in East Grand Forks and Crookston, and the Rogers Brothers and Pillsbury potato plants in Grand Forks destroyed fish food organisms and produced biological slimes in a 20 mile reach of the interstate

waters of the Red River of the North downstream from Grand Forks, North Dakota. The changes in the fish food populations and the production of slimes indicate that the water quality of the Red River of the North has been degraded sufficiently to interfere with the aquatic life resources.

* * * * * * * * * * *

Sewage and industrial wastes discharged to the Red River of the North and the Red Lake River from Minnesota cause pollution in the interstate waters of the Red River of the North which endangers the health or welfare of persons in North Dakota and, therefore, is subject to abatement under the provisions of the Federal Water Pollution Control Act. Sewage and industrial wastes discharged to the Red River of the North from North Dakota cause pollution in the interstate waters of the Red River of the North which endangers the health or welfare of persons in Minnesota and, therefore, is subject to abatement under the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et seq.).

RECOMMENDATIONS

The recommendations with regard to dissolved oxygen are based on the standard of 5 milligrams per liter of the Missouri Basin Health Council, to which both States subscribe. If the States desire a higher quality than recommended in this report, the objectives of the Federal Government with regard to the effects of interstate pollution on the oxygen resources of the Red River will be accomplished.

Red River of the North - Fargo to Grand Forks

1. Reduction of the waste load from the municipal treatment plants at Fargo and Moorhead will be required whenever flow is less than 80 cfs in the summer and less than 60 cfs in the fall. These flows, on a mean monthly basis, will occur about once in ten years.

2. During the once in 10 year low flow under ice cover, combined waste loads from the municipal treatment plants at Fargo and Moorhead must not exceed 2800 lbs/day of ultimate B.O.D. to maintain 5.0 mg/1 as a minimum D.O. in the Red River. Apportioning this load on a sewered population basis, Fargo may discharge 1950 lbs/day of ultimate B.O.D. and Moorhead may discharge 850 lbs/day of ultimate B.O.D.

3. Disinfection of the wastes from the municipal treatment plants at Fargo and Moorhead is required on a year round basis because of the large quantities of coliform bacteria discharged, and because of the isolation of pathogenic Salmonella great distances downstream from the waste sources under adverse environmental conditions.

4. To maintain 5.0 mg/l of D.O. in the river at all times, it will be necessary for the American Crystal Sugar Company plant at Moorhead to discharge waste in accordance with Chart II-5 of the Technical Appendix. During the once in 10 year low spring flows, a total of about 550,000 pounds of B.O.D. from the American Crystal Sugar Company at Moorhead may be discharged.

5. Because nutrients discharged in the sewage and industrial wastes from Fargo and Moorhead cause excessive biological growth downstream, the maximum practical reduction of the nitrogen and phosphorus in these wastes should be accomplished as soon as reasonably possible.

Red Lake River - Crookston to East Grand Forks

6. Reduction of the wastes from the American Crystal Sugar Company plant at Crookston, Minnesota will be required at river discharges less than 330 cfs to maintain 5.0 mg/l of D.O. in the Red Lake River. This flow can be expected on the average about three times in eight years. Experimental reduction in waste loads should be made to control the severe deleterious effect on the bottom-associated

and fish food organisms in this reach.

7. The excessive total and fecal coliform densities in the American Crystal Sugar Company wastes at Crookston should be reduced to ensure that the densities in the Red Lake River at East Grand Forks will not exceed the States' standard for a source of water supply.

Red River of the North - Grand Forks to the International Boundary

8. All sanitary sewage discharged to the Red River of the North at Grand Forks-East Grand Forks should be connected to the municipal collection systems and treated in the municipal waste stabilization ponds, or separate adequate treatment provided in accordance with present plans.

9. Wastes from the potato plants presently discharging to the Red River at Grand Forks should be collected and sent to the municipal system following in-plant treatment.

10. If the recommendation for treatment of the potato plant wastes in the municipal system is accomplished, the present discharge of 9,000 lbs/day of B.O.D. during the fall campaign from the American Crystal Sugar Company plant at East Grand Forks may be continued. However, if slime growths develop and accelerate the rate of deoxygenation and if the discharge creates a significant benthal demand, reduction of wastes during the fall may be required. No discharge can be permitted under ice cover.

CHAIRMAN STEIN: Thank you, Mr Sidio for a very comprehensize report

Are there any comments or questions from the conferees?

MR. SMITH: Yes.

CHAIRMAN STEIN: Mr. Smith.

MR. SMITH: I would like to start first and ask where you can direct me to the statement that the 5. 0 milligrams per liter as referred to throughout the report is a standard adtopted either by the Missouri Health Council or by the States.

MR. SIDIO: It will take just a minute to get the material.

CHAIRMAN STEIN: Mr. Sidio, if it will facilitate answering, you can call on any of your people to supply the answers.

MR. SIDIO: Thank you.

Tentative Guide for Water Pollution Control Activities, Missouri Drainage Basin, Section 4-C.

CHAIRMAN STEIN: Pardon, Mr. Sidio, would you identify the date of that publication?

MR. SIDIO: Yes. Water Quality Criteria, second printing, 1957. State Water Pollution Control Board, Sacramento, California, Publication No. 3.

MR. SMITH: I think you have gone far enough already. You refer to this as a tentative guide. Now, the reference throughout your report is standards. I think there is a considerable difference in the interpretation of standards and tentative guide.

CHAIRMAN STEIN: Do you have any other comment or is there any other comment from anyone else?

Do you?

MR. CLARE: I was wondering if Mr. Smith thinks the guide or standard or whatever you call it is too high or too low?

MR. SMITH: I think we will cover this in our statement, but I wanted it clear that continually throughout the report this is referred to as a standard and as subscribed to by the two states. Now, the two states' sanitary engineers are here, and I would imagine that they would be glad to comment on this. They are much more qualified to do that than I am. But I believe right at this point, the significance given to this in the report and the statement made that this is a tentative guide. As I understand it, later the word "tentative" was eliminated, but the difference between a guide and a standard as such I think is significant.

MR. VAN HEUVELEN: Mr. Chairman, these have not officially been adopted, I know, by North Dakota, for example by the State Health Council or the State Water Conservation Commission as standards for the State. These are guides that were adopted by the Missouri Basin Public Health engineering representatives from the various States as tentative guidelines, something we are shooting at, rather than as absolute standards.

CHAIRMAN STEIN: Are there any further comments or questions on that?

You know, we have some Federal legislation up just now, and I have been pretty much in telephone contact with Washington and they with me. It doesn't work the other way. When I get out, I hope I can hide, but I can't. What both these States have said is precisely what Senator Muskie has been saying to indicate that when the crunch comes the standards of the States somehow begin to evaporate and become guides or tentative guides and objectives, and I think they are proposing to remedy this by establishing Federal standards. The hope that I always had was that on a Federal-State program we could arrive at some kind of agreement to push forward and agree on what would be desirable or not. But I think maybe the Congress is going to speak for us and this may be past history, I don't know.

Go ahead.

MR. SMITH: I would like to object to that statement. I don't think that when the crunch comes that the States are backing off. You can't find anywhere where this standard of five parts per million has been adopted, and this is an interpretation placed on it by the Public Health Service without reason.

CHAIRMAN STEIN: I don't know that the Public Health Service has placed any interpretation.

MR. SMITH: This is the Public Health Service report to which you are referring.

CHAIRMAN STEIN: No, no. Let me make this very, very clear, that this report that is given is a report of the investigators for us who came forward. The reason we are sitting here at the Conference is to make a judgment on this. This is not a Public Health Service position other than the investigators. This is to be considered by the Conferees.

Now, again I don't think that I have misinterpreted, but I referred to Senator Muskie's position. His position is that these numbers thrown around tend to be ephemeral and that when you begin looking for a standard or something that has to be adhered to you generally don't find it. That is what I meant by when the crunch comes. I think the notion is when someone produces something they start with a fairly certain standard or requirement and we begin talking about that, it suddenly becomes not a standard but an objective or requirement or a goal.

By the way, I don't think it is at all fair to single out North Dakota and Minnesota in this respect, because I think what Mr. Smith and Mr. Van Heuvelen have alluded to is a fairly common practice among all the States, and this is by no means a unique problem here and this is by no means a criticism of anyone.

Are there any further comments or questions?

MR. SMITH: Don't you think, however, that people with less experience tend to feel that you can set a definite figure and this is it and those with additional experience and background realize that you can't set a definite figure and say this is it, it must not be above or below this figure?

CHAIRMAN STEIN: Well, in certain areas I think this is probably very true. In other areas, I guess it isn't. And I am not at all certain that in all areas you cannot set a figure. This may be modified, but you have been dealing with certain specific figures on water supply for years. I know in other areas such as restaurant and food protection and aviation we do have certain figures.

Now, I think with a lot of these figures, and I have been working with them for many, many years, as you know, Mr. Smith and Mr. Van Heuvelen I know has been working with them for many years, a lot of these figures are set because of administrative figures and they are set in a sense to be on the safe side, because we don't want to come up to the critical point or the danger point, and this is the problem with figures, with setting these figures.

I think in dealing, for example, with milk sanitation, we do have certain figures and requirements and maybe these figures are on the conservative side, but the reason that they are there is to preserve the purity of a milk supply. And I think this has generally been the technique of regulatory control in water pollution control, food pollution control or any method that we control the environment.

I know we had many, many arguments, Mr. Smith, just recently about the figures for radiation control and fallout. However, I do think that in order to maintain a control we did have to come up with a figure. Now, some people have always been for a higher figure and some people for a lower. I know we had this battle in radiation control when the technical people always wanted to reduce that figure as low as possible and others felt that the people could stand a little more radiation.

And I don't know that we have completely resolved this, but I think for administrative understanding we should come up with some kind of figure, and I am not--I don't particularly care what we necessarily call that figure, but we should work it out.

MR. VAN HEUVELEN: Mr. Stein, there has been a great deal of study on effluent standards for the Red River of the North and these have been considered by both States and used by both States. Both States have not considered a stream D.O. sample as such. And I think there is some danger in adopting a standard as we talked here of five parts per million by the Missouri Basin Engineering Health Council as applying to the Missouri River and trying to transfer it to another stream which has entirely different constituents and different characteristics, and you do run into some difficulties in that area.

Another point that may be of interest is that the International Joint Commission Board studying the river now has a committee studying proposed water quality standards at the border; in other words, as the water would cross from the United States to Canada. So both States really are in the process of establishing standards at this time on the Red River.

CHAIRMAN STEIN: Thank you. Are there any further comments of questions?

MR. SMITH: I still think that the implication throughout this report is that the States are not meeting the standard which they have themselves adopted, and I object rather strenuously to this. I think also the five parts per million or five milligrams per liter is qualified in the Missouri Basin Health Council objectives. It says in part, "For fish and acquatic life a minimum oxygen concentration of five parts per million is desirable in waters otherwise offering suitable fishery habitat with six parts per million for trout streams."

I have a series of questions. I don't know how long the Chairman would like to go before lunch?

CHAIRMAN STEIN: Well, I would think it might be wise, if there is no objection from the Conferees, possibly to defer until after lunch. Would that be agreeable?

MR. SMITH: It is all right with me.

CHAIRMAN STEIN: We will stand recessed until 1:30.

(NOON RECESS)

CHAIRMAN STEIN: May we reconvene? Mr. Sidio, would you come up. Are there any questions or comments of Mr. Sidio?

Mr. Smith.

MR. SMITH: I have just one or two more questions.

On your sampling procedures, could you tell me roughly how many samples were collected at the various sampling points? Take any particular point below Moorhead and Fargo, you collected samples at three different times?

MR. SIDIO· Yes.

MR. SMITH: Over what period of time each period, say, September, November and January?

MR. SIDIO: The period of time referred to as the September study went from August 31 through September 9. The November period, October 26 to November 13, there were 15 sampling days in that period of time and in January it was from approximately the 6th through about the 20th, or 13 sampling days during that period.

MR. SMITH: Were samples collected at each specific station each day, then?

MR. SIDIO: Yes, with one exception--that is with several exceptions of sampling stations. During the January period, there were several walk-in stations that we absolutely could not get to.

MR. SMITH: The other question has to do with the Salmonella. Now, these were--what technique was used in collecting these, the gauze technique?

MR. SIDIO: Yes.

MR. SMITH: And how long were these kept in the stream?

MR. SIDIO: For a period of five days.

MR. SMITH: Can you give us any particular significance to this? Now, I understand that the procedures have been developed considerably in recent months, in the past that probably you would not have been able to detect Salmonella, and the techniques have been improved to the point that this now can be done?

MR. SIDIO: This is a rather recent improvement of the method of isolating the Salmonella organisms. It has been developed in about the last year and a half or so.

CHAIRMAN STEIN: Let's have a direct answer to the question. Can this now be done?

MR. SIDIO: Yes.

CHAIRMAN STEIN: All right.

MR. SMITH: What would you indicate is the public health significance in this determination if the sampling device, the gauze pad, was left in the stream for a period of five days? This is not a quantitative determination in any way.

CHAIRMAN STEIN: Just one moment. If you want to call someone up who is an expert on this, why don't you?

MR. SIDIO: Yes. We have Mr. Ed Geldreich with us from Cincinnati. And I think he is much more qualified to answer these.

MR. GELDREICH: If I could, I would like to make a few comments on this particular subject before answering your question directly, give you a little background information.

I think first of all, this is a remarkable first attempt that the Public Health Service has been able to trace Salmonella and intestinal pathogens from sewer outfalls for distances in September of 22 miles downstream and find the same species, which is even more remarkable, because they have by showing that the same species is 22 miles downstream been able to verify with reasonable success that this is the same organism that probably came from the Moorhead sewer outfall or the Fargo-Moorhead sewage discharges.

If you were in a given time to analyze an animal who had Salmonella in him, you would find that there were certain species for a given period of time which would be predominant. These may change as time goes on. So for a given time period, you would expect if there was a sudden appearance of Salmonella in the sewage that it would have a certain pattern of types. This is apparently what they have found in their work.

Now, it is even more remarkable that in November they could detect this thing 62 miles downstream or three days' travel time. We have often wanted to be able to demonstrate these things, and until these newer approaches to techniques have come along we have had to do a lot of surmising up till now. In January they extended the isolation of the Salmonella to 73 miles downstream or equivalent to four days' travel.

So the organism is not delicate, as many of us in the past used to believe, pathogens are not fragile, they are very hardy individuals, they do persist for long periods of time, much as our coliforms and particularly our fecal coliforms do. And it is interesting to note that the fecal coliform picture at the same time, which is our quantitative determination of warm-blooded animal pollution, increased in the November and in the January run, in parallel with the fact that they found Salmonella greater distances.

It all seems to tie together that there is a potential increase in the health hazard associated with this.

CHAIRMAN STEIN: I am not sure you answered the question.

MR. GELDREICH: I am asking now, sir, would you rephrase your question? This is the background information. I would like to have the question.

MR. SMITH: Well, we appreciate that they have been found. We have been told by bacteriologists that a good bacteriologist, although he cannot find what he is looking for, does not say that it is not present, the techniques have not been developed sufficiently to find it possibly. Salmonella were found, the pads were left in the stream for a period of five days. You indicated, I think you have answered my question, that it is a potential health hazard. The degree of hazard, however, cannot be determined?

MR. GELDREICH: That is correct. The reason the degree cannot be measured in terms of so many number of Salmonella is that for you or I it may take an entirely different number of Salmonella to get us to have a diarrhea or dysentery. There are many factors involved in this which you have to take into account, the viability organisms, the number of individuals you are speaking of who may be more resistant or may have had some other illness that came along that weakened them so that the organism can be a problem.

I you were to give me a glass of water and I realized from my laboratory experiences that there was one Salmonella in that glass of water, I am not going to drink it regardless of all scientific endeavor that would try to tell me that maybe I would make it and maybe I wouldn't and still be healthy seven days later.

The hazard is potential that is what I am saying.

MR. SMITH: I just have one more question. Would you define for me bacterial population equivalents? It was defined in general terms, but I couldn't find in the report how you determined--

CHAIRMAN STEIN: I think we need an--

MR. GELDREICH: This is an engineering term.

CHAIRMAN STEIN: --engineer.

MR. SMITH: All right.

CHAIRMAN STEIN: Before you leave, Mr. Geldreich, on the last question, I think maybe you engineers or bacteriologists understand each other, but as I understand it, when you are talking about potential hazard, what you mean is when you are ingesting the Salmonella in effect you are playing a kind of pathogenic Russian roulette.

MR. GELDREICH: Russian roulette, that is correct.

CHAIRMAN STEIN: If you are debilitated to an extent or your constitution is such, you just might get something.

MR. GELDREICH: That is correct.

CHAIRMAN STEIN: All right.

Would you come up, Mr. Sidio?

MR. SIDIO: I think the question was define bacterial population equivalent?

MR. SMITH: Yes.

MR. SIDIO: As we have defined the B.O.D. population equivalent as being a certain oxygen demand from an individual in a period of one day, this is the same thing that applies to the B.P.E. or the bacterial population equivalent. It is the number of coliform bacteria ordinarily contributed from the wastes of one person during a period of one day. That number is four times ten to the eleventh power, which is four hundred billion coliform organisms that are contributed during the period of one day to a receiving water-course by one person.

MR. SMITH: I have no more questions.

CHAIRMAN STEIN: Any further comments or questions of Mr. Sidio?

MR. VEN HEUVELEN: I might just make an observation. I think the report is a very well put together report. I think if you go back and review the similar rather extensive survey in 1951, you will notice many similarities in the river, although there is a marked improvement in the lower reaches of the Red River from Grand Forks north in this report over the findings in the 1951 survey, which shows that the waste treatment that has been provided in the basin has accomplished some real purpose.

I think a number of people might be interested in a comment on this rather high coliform count of the sugar beet wastes. Where do these coliform come from? We know they aren't due to animals in the field, the harvest, and so forth, of the beets. Where do these coliform come from and what is their source?

MR. SIDIO: At the present time, we are at a loss to determine the source of the coliform bacteria in beet sugar processing wastes. We have initiated some work toward a determination of the source of these bacteria. The particular point that we wanted to bring out here is that there are coliform and including the fecal coliform originating from the waste of these beet sugar plants, and at present we have no means of differentiating between those that may be of human origin, animal origin as far as the fecal are concerned, and on the total coliform we cannot differentiate between those of soil and those of warmblooded animal origin.

In reality, the answer to your question is that at the present we do not know.

MR. VAN HEUVELEN: I think that is a good point to clarify. Another thing that we might clarify, I think all of us that are very familiar with the Red River know that there is a great deal of livestock feeding on its banks, there are certain areas where there is much wildlife raised, and again I would just like to have you reconfirm, we cannot differentiate either the coliform that originates from the cities from those that originate from these areas, is that correct? I mean you have not done so in this report, I don't believe.

MR. SIDIO: No, we have not. There is at present--

MR. VAN HEUVELEN: You can do it, I know, there are methods of doing it, but you haven't done so in this report.

MR. SIDIO: Not on fecal coliform.

MR. VAN HEUVELEN: No, that is right.

CHAIRMAN STEIN: Do you have anything?

MR. GELDREICH: We do have methods for identification--

MR. VAN HEUVELEN: Yes, I know this.

MR. GELDREICH: --on domestic wastes, which includes human. We do have methods for identification of the livestock segment from the domestic discharges, and more recently we have been able to associate pets and rodents with storm water run-off and we have three ways now that we can split this down.

To do this takes more data than was presented in the report. It takes a development of ratios of fecal coliform to fecal strep, a differentiation of the types of streptococcus which are present, and with the combination of this information we can fairly well key this down in one of those three areas.

MR. VAN HEUVELEN: I realize fully it could be done. That is why I wanted to point out it was not done in the report, though.

MR. GELDREICH: No, sir.

MR. VAN HEUVELEN: That is right.

CHAIRMAN STEIN: Are there any further comments or questions?

MR. CLARE: I would like to make a comment, Mr. Chairman.

I don't think it is necessary to point out to the conferees the importance of the lagoon method of sewage treatment in the Red River Basin. Actually, the method was pioneered in North Dakota, and many of us feel that if a lagoon is properly designed and built and operated that it is a very effective method of waste treatment.

I think without the lagoon in the Red River Basin, the problems of water quality in the Red River would be much greater than they are now. With this method of treatment, you are able to withhold wastes from being discharged to the river during critical periods. Critical periods could be either low flow or ice cover. And without this device, I think we would really be in trouble.

CHAIRMAN STEIN: Are there any further comments or questions?

If not, do you have any other Federal people to call on, Mr. Clare?

MR. CLARE: Yes, I do, Mr. Chairman.

We have with us from the Corps of Engineers District Office at St. Paul Lt. Colonel Leslie B. Harding, who is representing also his Division Engineer, Brigadier General Roy T. Dodge, and we would like to hear at this time from Colonel Harding.

COLONEL HARDING: Mr. Chairman, conferees.

Before I start this afternoon, I would like to introduce Mr. Myron Tiemens from our office. I am sure many of you have already met him. Myron is our Project Engineer for our studies of the Red River of the North Basin.

I appreciate this opportunity to outline for you the responsibilities and interests of the Corps of Engineers of the North Central Division as represented by General Dodge, my boss, and the St. Paul District in the control and prevention of pollution in the Red River of the North.

As many of you know, the Corps of Engineers is responsible for administering the laws enacted by Congress for the protection of navigable waters and for construction, operation and maintenance of improvements authorized by the Congress for navigation and flood control, including multiple uses for such as power, water supply and low river flow augmentation. Since the Corps does not exercise active jurisdiction over the Red River of the North in navigation matters, I will limit my remarks this afternoon to the Corps' activities in regulating stream flow for water quality control purposes. I will discuss three categories: First, projects which we have already completed, such as Lake Ashtabula Dam and Orwell Dam; second, projects which are authorized, which have been authorized by the Congress for construction but for which construction has not been initiated; and finally, those projects which are now being studied for possible future authorization by the Congress.

Since a definite policy for Federal participation in stream regulation for water quality control was not established until 1961, specific measures for such regulation have been included in relatively few completed projects. Most projects including such provisions do so because of unusual conditions which were considered to warrant Federal participation before the adoption by the Congress of a general policy for Federal participation in water quality control. However, in nearly all cases, operation of the reservoirs, and I would like to stress this, for their authorized purposes is incidentally beneficial to water quality control.

The value of the quality control features of these earlier projects and the increasing number of situations where low-flow conditions were becoming more critical, as demonstrated by the studies of the Senate Select Committee on Natural Water Resources, led to the adoption of the Water Pollution Control Act Amendments of 1961, Public Law 87-88, which provides that, in the survey or planning stage of any reservoir by the Corps of Engineers and any other Federal Agencies, consideration shall be given to the inclusion of storage for regulation of stream flow for water quality control. This legislation requires that such storage and water releases shall not be provided as a substitute for adequate treatment--and this, of course, is the most important aspect of the Act--shall not be provided as a substitute for adequate treatment or other methods of controlling waste at the source. The need and value of storage for regulation of stream flow is determined with the advice of the Secretary, Department of Health, Education, and Welfare, and his views are included in any report to the Congress proposing authorization or construction of projects including water quality control storage.

The additional authority contained in Public Law 87-88 places the Corps of Engineers in the position of being able to supplement the activities of the Department of Health, Education, and Welfare in abating pollution of the nation's watercourses. It provides definitely for considering low-flow regulation for water quality control at all future projects, including those authorized but not yet completed. For completed projects, however, this new authority merely provides the opportunity to consider recommendations for a modification of the existing projects, and this would now be done as part of a basin-wide study such as we are conducting now in the Upper Mississippi Basin where new projects are being considered.

Until significant progress is made on such basin-wide studies, including the comprehensive water quality studies of the Public Health Service, it is not possible to determine whether any significant number of our completed reservoirs could be economically and advantageously modified in the interests of water quality control. If future studies should indicate that modification of completed reservoirs would be practicable in many cases, it may prove desirable for the Congress to give blanket authorization to the Corps of Engineers to make such modifications when they are economically justifiable.

In summary, then, on our completed reservoirs and projects, we can continue to make minor modifications and adjustments in operations for water quality objectives whenever they are consistent with the purposes for which the projects were authorized and built, and we can recommend major modifications of completed projects to Congress whenever studies show this to be a justifiable or economical course of action.

In the Red River of the North Basin, the Corps of Engineers has five completed reservoir projects. I am sure most of you are acquainted with them: Lake Traverse at the head of the Bois de Sioux River in Minnesota and South Dakota; Orwell Reservoir on Ottertail River in Minnesota; the Red Lakes and their control works at the head of the Red Lake River in Minnesota; Lake Ashtabula, which I have already mentioned, on the Sheyenne River in North Dakota; and finally, the Homme Reservoir on the South Branch of the Park River, also in North Dakota.

All of these reservoirs except Lake Traverse have storages allocated for joint use for water supply and pollution abatement. During the severe drought of the 1930's, extended periods of zero and near-zero flows in the tributaries and portions of the main stem resulted in extremely acute water supply and sanitation conditions at municipalities and adversely affected rural areas. I am sure many of you still remember those days. Thus our flood control projects submitted to the Congress for authorization after the 1930 drought included provisions for stream flow regulation for water supply and water quality control. However, where benefits accruing from such regulation were local in nature, local interests were required to bear a portion of the costs of the structures. For example, for Lake Ashtabula local interests were required to contribute, and this was back in the late 1940's, $208,000 in cash toward the first cost of the reservoir, as well as to bear the costs of relocations and to construct and maintain a diversion dam and connecting channel between the Sheyenne and Red Rivers at Fargo. People in Fargo are well acquainted with the so-called Fargo diversion.

Now turning to the second category of projects already authorized and either not started or only partially completed. Public Law, which I have already mentioned, 87-88 provides a basis for considering modifications to previously authorized plans to include provisions for flow regulation for water quality control if the following criteria are met:

First, the modification of the project must be economically justified.

Second, the status of the planning and construction of the project must be such that it is practicable to accomplish the necessary changes without undue delay or unreasonable increase in cost over that which would have been incurred if water quality control had been originally authorized as a project purpose.

And third, the modification must not have a material adverse effect on the purposes for which the project was authorized originally.

Next, satisfactory advice must be received from the Secretary of Health, Education, and Welfare relative to the need for and the value of the water quality control storage.

And finally, the Congress must be informed of our intention to modify the project and of the views of the Secretary of the Department of Health, Education, and Welfare by letters to the Public Works and Appropriations Committees of both the Senate and the House.

At the present time in the Red River of the North Basin we have no projects in this category, projects which have been authorized but not constructed.

Of primary importance to the Red River of the North is the third category of projects which I mentioned in my introduction, those now being studied for possible future authorization. Now, the enactment of the Water Pollution Control Act of 1961 made it clear that the Congress wants water quality control to be considered just as fully as other purposes on which policy declarations have been previously made. We also find that in this category the Corps' prospective reservoir program may do the most good for water quality control.

At the present time, the St. Paul District has a number of studies under way of the water resource problems of the Red River of the North basin. Because of the urgency of the problems in specific areas, we are studying tributary streams individually. However, a basin-wide approach--I would like to emphasize this basin-wide approach--has been used to identify water needs and determine the value of storage for water supply and water quality control. We have recently participated in a joint study by Canadian and United

States agencies for development of the water resources in the Pembina River basin in Manitoba and North Dakota. Mayor Christopher is well acquainted with that. The results of the joint study were furnished in a report to the International Joint Commission early this year. At the present time I am not aware of the Commission's position on these proposed developments. At least they have not been made public as yet. But I can tell you that stream regulation for quality control purposes was considered in the study.

Other subbasin studies in the Red River basin include the Wild Rice and Red Lake Rivers in Minnesota and the Sheyenne, Goose and Park Rivers in North Dakota. In these investigations we are considering multiple-purpose reservoir storage. Such storage could provide benefits to flood control, water supply, water quality control, fish and wildlife, and recreation.

Early in these subbasin studies we recognized that they could not be completed independently or without considering the impact of tributary improvements on the water problems of the main stem of the Red River. We needed to know more about the economic growth picture of the entire valley, the water supply and water quality control needs on the main stem as well as along the tributaries, and the effects of proposed and existing reservoirs (both singly and in combination) on the over-all basin water resource needs. To obtain the needed information, we requested the Public Health Service to make an economic study for the basin, including a determination of areas of expected industrial expansion and a comparison of present and future water needs.

An advance copy of the Public Health Service report was furnished to our office late in July. We have our engineers reviewing in detail the data presented in the report to determine the storage requirements for water quality control in reservoirs being considered in our studies and the benefits attributable to such storage. Senate Document 97, of the 81st Congress, defines the benefits which may be accrued from water quality control as follows:

"The net contribution to public health, safety, economy, and effectiveness in use and enjoyment of water for all purposes which are subject to detriment or betterment by virtue of change in water quality. The net contribution may be evaluated in terms of avoidance of adverse effects which would accrue in the absence of water quality control, including such damages and restrictions as preclusion of economic activities, corrosion of fixed and floating plant, loss or downgrading of recreational opportunities, increased municipal and industrial water treatment costs, loss of industrial and agricultural production, impairment of health and welfare, damage to fish and wildlife, siltation, salinity intrusion, and degradation of the esthetics of enjoyment of unpolluted surface waters, or, conversely in terms of the advantageous effects of water quality control with respect to such items. Effects such as these may be composited roughly into tangible and intangible categories, and used to evaluate water quality control activities. In situations where no adequate means can be devised to evaluate directly the economic effects of water quality improvement, the cost of achieving the same results by the most likely alternative may be used as an approximation of value."

The Public Health Service has indicated in their report to us that presently available sources of water, including the flow supplements obtainable from the existing Corps of Engineer reservoirs, are generally adequate to meet the year 2015 water supply needs, projection of 50 years hence, except that fairly substantial additional amounts will be required on the Park River at Grafton, North Dakota, by the year 1990. Storage for water supply at Grafton will be considered in the study that we are already making for the Park River flood control.

As for the water quality control needs of the basin, the Service has found that existing Corps of Engineers' reservoirs are able to meet the 2015 requirements for supplemental flow for dilution of municipal and industrial wastes except at Grafton, North Dakota, and Ada, Barnesville, and Detroit Lakes in Minnesota.

As I have already mentioned, we will consider storage for water quality improvement at Grafton in our reservoir study on the Park River. The Public Health Service has suggested diversion of natural flows from the Wild Rice River to meet the needs on Marsh River at and below Ada and a holding pond for waste discharges on Willow Creek below Barnesville. As for Detroit Lakes on the Pelican River, we are not aware of any flood problems in the Ottertail River in that reach. At the present time we have no reservoir studies planned for that subbasin. Orwell Reservoir is located on the Ottertail River downstream of this area and, therefore, cannot be regulated to improve the conditions at Detroit Lakes.

The most significant need for stream flow regulation for water quality control indicated by the Public Health Service is that required to offset adverse mineral quality deterioration attributable to return flows from irrigation anticipated through the operation of the authorized Garrison diversion unit of the Missouri River basin project. The Service indicates an annual storage requirement of 80,000 acre-feet on the eastern tributaries of the Red River above Fargo and 60,000 acre-feet in the proposed reservoir on the Sheyenne River to assure that total dissolved solids criteria at Fargo and Grand Forks are met. In lieu of storage on the Sheyenne River, the Public Health Service suggests that comparable quality control could be obtained by providing 150,000 acre-feet of dilution storage in eastern tributaries upstream from Grand Forks.

You may be sure that we will consider these alternatives in our planning for reservoir storage on the tributary streams and that the most economical and practical plan will be selected for inclusion in any recommended plan of improvement.

One of the most vexing problems encountered in our Red River basin reservoir studies has been the physical limitations of available storage sites. Thus, although the beach-ridge escarpment areas bordering the valley do provide good structure sites, the storage capacity obtainable in these prospective sites is often too small to permit desirable reductions in major flood flows.

In summary, then, we plan to cooperate with the Public Health Service and the States concerned in our further basin reservoir study, and I can assure you that full and appropriate consideration will be given to the role which reservoir storage can play in resolving the present and anticipated future water pollution problems in the Red River of the North basin.

Thank you, Mr. Chairman.

CHAIRMAN STEIN: Thank you, Colonel Harding.

Are there any comments or questions?

If not, thank you very much. I think this gives you a notion of the complexity of the closeness with which we work with our sister agency, the Corps of Engineers, in water resources development and water quality control. Thank you again, Colonel Harding.

Mr. Clare.

MR. CLARE: We have some representatives of the U. S. Department of Interior. Here representing Mr. Harrell F. Mosbaugh, Regional Coordinator of the Missouri Basin Region, from Billings, and Mr. Harold Aldrich, Director of the Bureau of Reclamation of Billings, is Mr. Phil Gibbs from the Bureau of Reclamation at Billings.

MR. GIBBS: I am Phil Gibbs, Chief Hydrologist for the Bureau of Reclamation, Region VI, Billings. This statement is for the Bureau of Reclamation.

Garrison Diversion Unit, providing for

irrigation of 250,000 acres, has recently been authorized. Missouri River water will become available in a few years to help alleviate the pollution problem now existing in the Red River of the North. This water is expected to average 500 parts per million total dissolved solids.

Plans for the development include provisions for the restoration of Devils Lake and Stump Lakes to a fresh water condition. Several preliminary studies have been made to approximate the scope and magnitude of the problem, but no plan has been finalized. It is plain that flushing and filling should be accomplished as rapidly as economically possible, and that it should be initiated early while surplus storage and canal capacities are available and before irrigation begins to deteriorate the water supply. Depending on criteria fixed by other interests, the restoration could take many years.

Upon completion of the restoration process, it is planned to release at least 15,000 acre-feet annually for continued pollution control in the Sheyenne and Red Rivers.

As irrigation develops, the return flows are expected to increase until they amount to about 66,000 acre-feet annually. This is an average of about 92 second feet. These waters will have an average concentration of about 1,350 parts per million total dissolved solids. We estimate about 44,000 acre-feet will accrue in the Sheyenne Basin and about 22,000 acre-feet will originate in the Wild Rice River.

The Bureau of Reclamation is interested in developing a flush-and-fill plan for the Devils Lake area which will be satisfactory to all participating agencies and departments, an irrigation development which will be successful and sustained, and an ultimate project which will contribute to good water quality at downstream cities and industrial areas. Reclamation, as the constructing agency, solicits the suggestions and assistance and cooperation of all other Federal agencies, State organizations, towns and cities, in arriving at satisfactory plans and at solving our common problems.

CHAIRMAN STEIN: Thank you, Mr. Gibbs. Are there any comments or questions?

If not, thank you very much, sir.

MR. CLARE: Thank you.

Also here today from the U. S. Department of Interior is a representative of the U. S. Geological Survey. We use a great deal of information from the Survey, and we were fortunately able to arrange for this on a reimbursable basis. The District Engineer for the Survey is here today, Harlan Erskine.

Do you have any statement you want to make?

MR. ERSKINE: We have no statement.

MR. CLARE: All right, thank you. We are glad you are here, sir.

Also from the Department of Interior, from the Bureau of Sport Fisheries and Wildlife, Minneapolis, is Donald D. Vogtman. Is Mr. Vogtman here?

Do you have a statement, sir?

MR. VOGTMAN: Yes, sir.

The Bureau of Sport Fisheries and Wildlife is vitally interested in protecting and enhancing the quality of the nation's waters. The Bureau has signed a Memorandum of Understanding with the Department of Health, Education, and Welfare concerning water pollution control. This agreement was developed in recognition of our common interests in the field of water pollution and to make possible a more effective program of interagency cooperation.

The basin of the Red River of the North provides lakes, streams and marshes, all of which are essential to the protection of fish and wildlife. Extensive marsh habitat of the basin is of national importance for waterfowl production. The lakes and reservoirs attract tourists from across the nation for the excellent fishing. Too often, however, the rivers and streams have been subjected to the effects of flooding, drought and pollution. Fishing and hunting opportunities are lost during or following such periods.

Limited gradients and channel capacities of the main stem of the Red River, together with extensive drainage on the upper watershed, have accentuated flood problems. Snow melt in the southern portion of the basin precedes that on the northern outlet, increasing the flood potentials. The other extreme, drought and low-flow periods, results in stagnant conditions not conducive to production of either fish or wildlife. Serious pollution is caused by municipal and industrial wastes. Excessive siltation results in turbid, unattractive conditions. The ill effects of pollution are increased during times of low flow and during extended periods of ice cover. Oxygen is limited during such periods and the quality of the fishery deteriorates, with rough fish tending to dominate.

Stream flows in the Red River of the North and its major tributaries are highly variable. Within a single year, both flooding and drought conditions may be experienced. This wide variation in flows adversely affects agriculture, industry and fish and wildlife. Low-flow conditions create unpleasant blooms of algae and stagnant water conditions. Fishery management is rendered most difficult.

The Fargo-Moorhead and Grand Forks area contribute an especially heavy burden upon this river, which has only limited ability to absorb the pollution load during a large part of the year.

Regulation of minimum flows in the main stem of the Red River of the North would aid in pollution control and help to create more favorable environmental conditions for fish and other acquatic life. In addition, problems generated by intensive agricultural production of sugar beets, potatoes and onions, together with industrial pursuits and the accompanying increase in chemical pollutants, including herbicides and pesticides, should be investigated.

Physical and biological considerations in the Red River will limit the establishment of highly productive sport fisheries in these waters. However, the existing and rather limited fishery could be considerably improved by pollution and siltation abatement.

Before the Red River and its tributaries can support a good quality fishery, pollution, siltation, and low-flow conditions must all be controlled. This will not be without its problems, for reservoirs are a necessary prerequisite to providing minimum flows during low-flow periods. Sites for such reservoirs on the tributaries of the Red River must be carefully selected, or this in turn will generate substantial wildlife losses which could outweigh fishery benefits. Studies carefully coordinated with the project planners will be necessary if optimum over-all benefits are to be realized.

CHAIRMAN STEIN: Thank you, Mr. Vogtman. Are there any comments or questions?

If not, thank you very much, sir.

MR. CLARE: We have here a representative of the U. S. Forest Service, David Hedrich, Regional Watershed Specialist.

Mr. Hedrich, do you have a statement you would like to make?

MR. HEDRICH: The Forest Service has no statement to make.

MR. CLARE: Thank you. We are glad you are here, sir.

I believe that concludes the list of Federal representatives that I have.

Let me ask, is there anyone here from the Bureau of Outdoor Recreation, Department of Interior? They were uncertain whether they would be able to send someone or not. I guess not.

And if my notes are correct, that concludes the statements from the Federal representatives, Mr. Chairman.

CHAIRMAN STEIN: Thank you. If there are no comments or questions of the Federal presentation, we would now like to call on North Dakota.

MR. VAN HEUVELEN: Thank you, Mr. Stein. First of all, I have a few people who I know want to testify on behalf of the State of North Dakota. I feel that there might be others in the audience, and if anyone wishes to make a statement and I have not contacted you, would you please somehow get your name to me before we close this off.

CHAIRMAN STEIN: After your first statement has been presented, we may be able to recess and let them come up and consult with you then.

MR. VAN HEUVELEN: Okay, that is fine.

The first person who would testify for North Dakota or give testimony is Mr. Norman Peterson, Director of Division of Water Supply and Pollution Control in the North Dakota State Department of Health, who has a prepared statement to give at this time.

MR. PETERSON: Chairman Stein, conferees, ladies and gentlemen. I am happy to be up here on behalf of the North Dakota State Health Department to present this statement to you.

The statutes in North Dakota place the responsibility for water pollution control in our State with the North Dakota State Health Department and the North Dakota State Water Conservation Commission. Laws pertaining to the pollution of water by acts of individuals as well as communities and industries have been in effect for many years. Over the ensuing years, the laws have been amended and changed. Generally, the amendments were to keep pace with the changing environment and the required uses of water. Attached to this statement is a summary of the water pollution control laws and regulations that are in effect in North Dakota at the present time. Two of the existing State laws were amended by the 1965 Legislature. One amendment states that municipalities within the state may not discharge untreated sewage or wastes into any river after July 1, 1967, while the other amendment defines pollution.

The wording of the existing State laws give the State Health Department the prime responsibility for water pollution control in the state. Municipalities may discharge their wastes to any stream, lake, coulee, or slough in the state providing they have approval of the treatment methods to be used from the State Health Department and the State Water Commission. Such approval is only granted when adequate treatment has been provided the wastes. The type of treatment required is in direct relationship to the characteristics and conditions of the receiving waters. All municipalities are required to submit plans and specifications for proposed treatment facilities to the controlling agencies prior to construction. In accordance with the law, the State Health Department must review and approve the plans for these facilities before approval by the State Water Commission. It is also necessary that these plants or treatment facilities be operated and maintained in accordance with the rules and the regulations that have been established for the prevention of water pollution. The above statutes and regulations also pertain to industries and industrial wastes.

The North Dakota State Department of Health has been active in water pollution control on the Red River for many years. In 1931, 1932, and 1933 joint investigations were made by the North Dakota State Board of Health, the Minnesota State Board of Health, and the Minnesota Department of Conservation. Another study was made early in 1938 by the Departments of Health from North Dakota and Minnesota. The conclusions of this study resulted in a new study which was far more comprehensive and began in the fall of 1938 and continued into 1940. The report of this study was published by the North Dakota State Department of Health. The publication is available and entitled "Red River of the North Research Investigation." In 1944, the interstate sanitation committee was formed. This committee was composed of representatives from the Departments of Health of Minnesota, North Dakota and South Dakota, the North Dakota State Water Commission and the Minnesota Department of Conservation. One prime responsibility of the committee was to recommend plans and methods for interstate cooperation on the part of the states involved in dealing with pollution problems in the Red River drainage basin. The recommended standards of treatment for municipal and industrial wastes in the river basin, drawn up by this committee in 1949, were adopted by the three states concerned the same year and are still used as guidelines for approval of treatment facilities for municipal and industrial wastes.

A copy is attached. In 1950 and 1951 the State Health Department cooperated with a number of other states and the U. S. Public Health Service in the Missouri-Souris Development Area Water Pollution Control Investigation. The study included the Red River of the North. This investigation and study together with the data received from previous studies mentioned formed the basis of a program developed by the State Water Pollution Control Agencies of North Dakota, Minnesota and South Dakota entitled "A Comprehensive Water Pollution Control Program for the Red River of the North Basin" in 1953. This comprehensive program was adopted by the Surgeon General of the U.S. Public Health Service as fully meeting the requirements of the Federal Water Pollution Control Act. The program noted that 21 municipalities and five industries in North Dakota on the main stem of the Red River or on its tributaries needed new treatment facilities or additions to existing facilities. At the present time, 16 of the 21 municipalities have met the requirements of the program. Of the remaining five municipalities, (three with primary treatment, two with no treatment) three are on the upper end of tributaries and it is questionable whether their pollutional effects would be noted on the main stem. This does not, however, relieve these municipalities of their responsibility for water pollution control on the tributaries. As soon as present plans by the City of Grand Forks have been completed, all of the industries noted will no longer constitute a direct pollution load on the main stem of the Red River. And I believe the City of Grand Forks is going to present a statement that will bring this out further.

The North Dakota State Health Department has made a number of spot surveys of the Red River at various times over the years. These were not comprehensive surveys over the entire basin and were made for specific purposes at the time. Considering all the surveys that have been made on the Red River by the states involved, it can probably be said that it is one of the most surveyed streams in the United States.

The North Dakota State Health Department is pleased with the manner in which the municipalities located in the Red River Basin, in North Dakota, have accepted their responsibilities in providing adequate treatment of all their wastes. Attached to this statement is a listing of all the municipalities on the main stem of the river and its tributaries. Information is also provided on the population, type of treatment provided, the year of construction, and the cost of the treatment facilities. The cost date is limited to the time after January 1, 1957, as no breakdown of cost data was kept prior to this date by the Department. We probably have the over-all cost but no breakdown just on the waste treatment. The costs also include any Federal Grant monies received by cities in the amount of 30 percent of the eligible costs of the treatment facilities.

There are a total of 75 municipalities in the

Red River Basin area. Only seven are located directly on the main stem. The population of the seven communities, 1960 census, was 89,301. The population of the remaining 68 communities was 62,917.

Five of the seven municipalities on the main stem have provided adequate treatment since 1958. The total money spent on these treatment facilities, either new or additions to existing facilities, by these five communities was $4,680,840 or approximately $37 per capita. The two remaining communities are the smallest on the main stem with a combined population of 747. One has informed the State Health Department that they have started planning to replace their primary treatment with adequate facilities next summer. The other community has been told by the State Health Department that they must provide adequate treatment. The amended State statutes also affect this community.

The remaining 68 new communities lie on the various nine tributaries to the Red River. The Sheyenne River is the largest tributary in North Dakota and contains 28 communities. The two smallest tributaries are the Maple and Elm Rivers with only two communities in each of these basins.

49 of the 68 communities located on the tributaries to the Red River have brought their treatment facilities up to the State Health Department's standards since January 1, 1957. Many of these communities replaced old outdated treatment facilities with waste stabilization lagoon systems. The total money spent on treatment facilities in these 49 communities was $2,784,900 or approximately $31 per capita. The Grand Forks Air Base, discharging its waste to the Turtle River, has spent considerable monies during the recent years, but no information on the total money spent by the Air Force is available in the State Health Department office.

The summary of the cost data reveals that 54 of the 75 communities in the basin have constructed adequate waste treatment facilities in the last eight and one-half years. The total cost of these facilities was $7,465,740.

From 1950 to 1957, eight of the remaining 19 communities provided adequate treatment for their wastes. Of the remaining 11, two have secondary treatment, eight have primary treatment and one does not treat its wastes.

The summary total of the 75 communities in the basin is that 73 are providing treatment: 65 providing secondary treatment or equivalent and eight with primary treatment. When I say equivalent I mean the waste stabilization lagoon system. We have found that a satisfactorily operating lagoon will give excellent treatment of wastes.

Industrial wastes are becoming a major factor in the State's water pollution control program. In the Red River Valley Basin, the potato processing industry has increased rapidly in the past years and at present is our major concern. These industries, like our communities, have been very cooperative and the State Health Department has worked closely with them toward providing adequate treatment for their wastes. A major obstacle in the treatment of potato processing wastes has been the complete lack of any technical information or experiences in any other states on how this particular waste is best treated. The State Health Department, with the cooperation of industry, the potato growers associations, and municipalities involved are presently testing various methods of treatment to determine which would be the most economical and feasible for these industrial wastes and yet prove satisfactory. Financial assistance in the form of demonstration grants have been obtained through the Public Health Service to assist with the problem. All of these industries have installed primary treatment as a means of reducing the strength of their wastes before discharge.

The major industries in the Red River Basin, in addition to the potato processing industry, are the meat packing industry in Southwest Fargo, the Union Stockyards in West Fargo, the Crystal Sugar Plant at Drayton and the State Mill and Elevator at Grand Forks. At the present time, the only industries discharging directly to the main stem are those located directly north of the City of Grand Forks. The city is now drawing up plans to connect up these industries to the city's sewer collection system. The industries will still be required to provide primary treatment before discharge to the city's system. Final treatment of the wastes will then be accomplished in the Grand Forks waste stabilization lagoon facility. The Crystal Sugar Plant at Drayton is a new industry starting this fall. The plant has constructed a series of detention lagoons and will initially reduce their wastes by recirculation and reuse of waste water within the plant.

It is the opinion of the North Dakota State Health Department that excellent progress has been made in the control and abatement of pollution in the Red River Basin. This progress could have only been accomplished with the excellent cooperation of the numerous communities in the basin that have recognized their responsibility for proper treatment of their wastes and have proceeded to construct adequate waste treatment facilities. It is true there are a few communities that have not taken appropriate action and it will be necessary for these to do so. The State Health Department believes that the problem of an adequate and feasible method of treating potato processing wastes will soon be solved. As in the past, any new industry discharging wastes or a municipality installing a sewage collection system will be required to provide adequate treatment that meets the requirements of the State Health Department and the State Water Conservation Commission.

It is the opinion of the North Dakota State Health Department that the Red River of the North and its tributaries must be used to its greatest potential for the economic development of the basin. Because of the lack of acceptable ground water supplies in the valley adjacent to the Red River, at no time should the stream's water quality be degraded to a point where it is no longer acceptable as a source of water supply for municipalities and industries located on the Red River.

Mr. Stein, that concludes my statement.

CHAIRMAN STEIN: I assume you want the attachments included in the record?

MR. PETERSON: If you please, sir.*

CHAIRMAN STEIN: With no objection, that will be done.

Are there any comments or questions?

I have one. There was one thing I was looking for, Mr. Peterson. You talked about your new definition of pollution, but then I looked back and I didn't find it. I have a question of what it is and let me tell you what I am driving at. Does this deal with pollution that deals with injuries for all legitimate uses or just specific ones?

MR. PETERSON: It deals with everything. It is taken almost verbatim from the recommended definition by the Public Health Service.

CHAIRMAN STEIN: All right.

I may have one other. As I understand the situation, at least dealing with your standards for treatment of municipal and industrial wastes, where you talk about composite B.O.D. and suspended solids, and so forth. I understand if industries and municipalities met these requirements, they would meet the recommendations of our investigator's report. Am I correct in that assumption as far as this is concerned? In other words, I don't think there really is a difference. If there is, I would like to hear it.

MR. PORTERFIELD: May I ask a question? Does that mean five parts per million?

* See Appendix III

CHAIRMAN STEIN: Wait a moment. I am sorry, you will get a chance to come up. We can't take that from the floor.

MR. PETERSON: That is not included in these standards.

CHAIRMAN STEIN: So I guess there is a difference?

MR. PETERSON: There is a difference.

CHAIRMAN STEIN: Thank you.

Are there any further comments or questions? That was a very excellent, clear statement, I think, of North Dakota's position.

Do you have one, Mr. Clare?

MR. CLARE: Yes. Mr. Peterson, could you indicate what you mean by adequate treatment as far as effluents received by the main stem of the Red River? Would you say this is equivalent to secondary treatment? Does it include biological treatment or in some cases will primary treatment be adequate?

MR. PETERSON: No, we have always been of the opinion that secondary treatment or its equivalent will be necessary on the Red and its tributaries.

MR. CLARE: I see. You referred to primary treatment by industry. You meant that this would be what is equivalent to the in-plant treatment by industries and then secondary treatment would be required?

MR. PETERSON: Well, frankly, see, on the industries, we are trying to find some way of physically treating--I am thinking of the potato wastes--trying to find some way of economically and feasibly treating the waste, but meanwhile we have asked them to put in primary treatment until we come up with something on it. But I understand, of course, most of our potato plants are going to be taken care of now in the Grand Forks area by the City of Grand Forks anyway, so I think that will probably be brought out by Mr. Forsman's statement.

CHAIRMAN STEIN: There was a recommendation, as I recall it, in the Public Health Service report, and again what I am trying to do is to narrow the issue if I can. This is substantially what your plan is, isn't it?

MR. PETERSON: Yes. Actually the recommendation that is in the report, the pollution survey report, was put in there because of the information we gave them.

CHAIRMAN STEIN: That is right. But again I want to find out, are you in substantial agreement on this recommendation?

MR. PETERSON: Oh, yes, we are definitely.

CHAIRMAN STEIN: You recall it?

MR. PETERSON: Yes, that the industry go into the Grand Forks sewer system.

CHAIRMAN STEIN: That the industry go into the Grand Forks sewer system and that no discharge be permitted under ice cover, and they say if slime growths develop and accelerate the rate of deoxygenation and the discharge creates a significant benthal demand, reduction during the fall may be required.

MR. PETERSON: If they go into the Grand Forks sewer system, there will be no discharge by industry directly into the river, period, because they will then be connected up to the City system and be going into the Grand Forks stabilization lagoon system.

CHAIRMAN STEIN: How about a discharge of that sewage system during ice cover?

MR. PETERSON: I don't recall that Grand Forks has ever discharged under ice conditions from their stabilization lagoon.

CHAIRMAN STEIN: Right. In other words, then, you are in agreement with this?

MR. PETERSON: That is right.

CHAIRMAN STEIN: That is what I was trying to get at. Thank you very much.

I think this is probably a significant point, because I think all hands agree that at the present stage of the art treatment of potato wastes is a real vexing problem, and if we arrived at an agreement on how to handle this in this area through the municipal systems, this seems to me indeed fortunate.

Thank you very much.

MR. VAN HEUVELEN: Mr. Stein, we do have Mr. Gordon Gray, with the State Water Conservation Commission. I believe Mr. Gray has a statement to make.

MR. GRAY: Chairman Stein and Chairman Van Heuvelen, able conferees, ladies and gentlemen.

The North Dakota State Water Conservation Commission is represented here today by Mr. Water of North Dakota, Fred Fredrickson, and by the staff's Chief Hydrologist, Dale Glover, and myself.

The responsibility of the North Dakota Water Conservation Commission is one of cooperating with the State and Federal agencies whose main concern has been so capably presented today, and that is to include health as a portion of our considerations in water development.

We would like to congratulate Governor Rolvaag for calling this meeting, and we are happy to be a part of it. We pledge our support to the State and Federal agencies and will cooperate in any way possible to further the demands of water today.

There does exist a Red River Valley Basin Planning Committee. This committee is comprised of the two governors, Governor Rolvaag and Governor Guy, and the governors appoint two committee members from each state. This committee has met and shall continue meeting, and I am pleased to report that action that transpired in the Congress of the United States this year as covered by Senate Bill No. 21 and represented now by Public Law 89-80, was signed by the President in July of this year and provides for the establishment of a permanent river commission or basin commission, and we expect that the Red River Valley Basin will have a permanent commission, so that matters of this nature may receive more tangible consideration and we are looking forward to assisting in matters that were so ably and comprehensively detailed today.

Thank you.

CHAIRMAN STEIN: Thank you very much, sir.

Are there any comments or questions?

If not, I would like to draw this out, and this doesn't necessarily relate to your statement, Mr. Gordon, which was really complete. But as I understand our technical staff position, Mr. Van Heuvelen, they have indicated that if the municipalities and the industries, all the municipalities and industries met those standards you have outlined in the back, they would undoubtedly beat the five parts per million. Now, I suggest if we are going to be here for some part of the day yet that when we recess and get together again you may want to consider this, because this may be a crucial point. If you are saying the same thing, I think we should know that. If there is a difference, then perhaps there is a difference.

But I think our function here or one of our large functions is to try to clarify the issues and define them as much as possible.

MR. VAN HEUVELEN: I don't think that just by meeting these treatment requirements they would necessarily meet the five parts per million, because that will be somewhat determined by flows.

CHAIRMAN STEIN: I think your point is well taken, and I think again if this is maybe--

MR. VAN HEUVELEN: So I don't see how you could tie effluent standards to stream standards.

CHAIRMAN STEIN: Yes. I wonder if you would permit--has your committee completed your presentation?

MR. VAN HEUVELEN: No, we have some others.

CHAIRMAN STEIN: Well, maybe we can wait until you are through and take this up.

MR. VAN HEUVELEN: We do have in the audience Mr. Russ Stuart, who is our Game and Fish Commissioner.

Mr. Stuart, do you have a statement you wish to make?

MR. STUART: Chairman Stein, ladies and gentlemen, I have no prepared statement, but in listening to this discussion today I would like to make two or three observations.

I happened to attend a conference on pollution two years ago in Washington, D. C., called by the National Wildlife Federation, and during that Conference there was one man got up and make a statement which I think is rather profound. His statement was:

Dilution of pollution is no solution.

There has been some, as I detect, little difference of opinion between what constitutes pollution or what the standards should be. From the standpoint of game and fish management, we realize that standards are important, but I think we realize more whether or not pollution exists. Insofar as fisheries are concerned throughout the United States, I think the records of H.E.W. will show that at least 18 million fish were killed because of pollution throughout the United States this past year.

It is rather difficult to define pollution. Today we have been talking about municipal and industrial wastes. Insofar as the Conservation Department is concerned, pollution goes far beyond that. If there is too heavy a silt load being carried in the river, it definitely constitutes a form of pollution. We have a stream in western North Dakota known as the Heart River where because of mismanagement of much of the land on the watershed there are considerable amounts of a colloidal clay going into a reservoir that definitely affects the fisheries in this area and it is very deleterious.

Insofar as we are concerned as far as the Red River, we have felt that it has been polluted for a good long time, and I think the fact that game fish are unable to live in the rather lengthy portions of the Red River is an indication that this pollution exists. What the solution to it is, I do not know. But I believe that this whole field of pollution is important to every one of us and every one of us have a stake in it. I have seen pollution on a tributary of the Red River and the Sheyenne River by individual farmers, and I know that they are doing it without thinking of what the results may be downstream. As a matter of fact, any one of you can fly from Valley City around the Sheyenne River in the wintertime and you will find cattle feeding operations right out on the ice. This is natural, because it is perhaps the best wooded area along the stream and it makes a natural place to feed cattle. Definitely it is contributing to pollution. By the same token, I am sure that you can find people dumping barbed wire, old car bodies, and so forth, in the rivers, which in our estimate is another form of pollution.

You talk about five parts per million of dissolved oxygen. We also know that certain chemicals known as pesticides wherein there can be less than one part per million can be very detrimental to fish life, so that we feel this is a tremendous problem and we as conservationists are mighty concerned with it, not only on the State level but on the national level, and I think you are going to have to realize that more money is going to be spent in solving pollution problems.

About two years ago, the City of St. Louis floated a bond issue for 96 million dollars to take care of the pollution caused by the City of St. Louis.

Thank you.

CHAIRMAN STEIN: Thank you, Mr. Stuart. Are there any comments or questions?

MR. CLARE: Mr. Chairman, I think that is a very fine statement. I would like to correct something for the record, though, Mr. Stuart. This bond election was by the Metropolitan St. Louis Sewer District, which comprises some 80 municipalities in addition to St. Louis.

CHAIRMAN STEIN: By the way, that was done as a result of one of our enforcement cases.

Mr. Stuart, I would like to, and I know the conservationists are here, make a comment or two. I agree with practically everything you say. I think in relationship to any numbers used here, whether the five parts per million or what-have-you, the only reason they are used is in relation to water uses. That is, whatever we say the number is, if we don't set the right number, fish aren't going to propagate and they are going to die. They are not very much interested in the number we set.

Our job if we are going to restore our rivers for fisheries to keep fish alive, if we are going to make it safe for water contact sports, is to reduce the bacteria so people will not have a hazard when they get near it. And the numbers are for that purpose.

With that I would like to give you one limitation in the process that we have here, and I think this goes with the state water pollution control agencies, although we do have agricultural representatives here. For example, under most State and the Federal law we can just do so much in pollution control. Generally speaking, silt control at the present time is beyond the scope of a process such as this. Silt comes either from subdivisions, road building, perhaps unsatisfactory farm practices, or somewhere else, and it is very difficult to put the responsibility on specific polluters. At the most in a case of this kind, you get either a handful, perhaps as we have on the Red River, or maybe a couple of hundred identifiable ones. Silt control requires some other techniques rather than a State or Federal regulatory technique to get at.

The reason I say this is we are just completing a program of pollution control in the Potomac River near Washington.

We think we have, and I am sure we have, eliminated the health hazard for people who come into contact with the water, and that water used to be pretty bad. For example, I think the coliforms generally are less except after a rain and that is going to be corrected by next year or so, generally better from a bacterial point of view.

At Coney Island, New York, where millions of people swim, we have eliminated the sight and odor nuisances, and if you visited Washington several years ago and crossed the Potomac, I don't have to tell you what I mean by that. You can cross the Potomac now and if your eyes are closed you won't know it, it is not too bad, most of it. And I think we are restoring the game fish to the area.

However, the people there ask us, okay, when can we swim in the river? And the point is at the present time you can't and largely because of the silt and sludge. We have 50 years of neglect and all that sludge on the bottom; goodness knows how it is going to get out.

The second thing, the river is so murky that for safety reasons if anyone had to look for a body below the surface, they just couldn't find it. So you really couldn't permit swimming But we pointed that out at the beginning, that we were not going to clean up the silt problem, and when people look for a clean river, they are not satisfied.

I think a good deal of the Red River problem can be solved, if I understand the State reports and our report. But again I think all the people in the room should recognize the limitations of a pollution control problem, and while I recognize and I think we all recognize that in some areas silt or other forms of materials may indeed interfere with the use of a river, there are other techniques we are going to have to use to get at that rather than what we are doing here. Not that our job isn't the first step and very, very important, but you have to recognize the limitations of what the Federal and the State program can do.

Thank you. Mr. Van Heuvelen.

MR. VAN HEUVELEN: We do have a representative from the City of Fargo who is Superintendent of the Water and Sewage Utilities, Mr. Ken Ruby, who has a statement.

MR. RUBY: Chairman Stein, conferees, ladies and gentlemen.

The City of Fargo has had a sewage treatment plant since 1936. This was a secondary treatment plant with settling basins, trickling filter and separate sludge digestion with sludge drying beds.

In the 1950's this plant became inadequate in size. In 1960 construction was begun to enlarge and modernize the treatment facilities. This construction was completed in September of 1964.

The new plant provides for primary aeration and settling. Secondary treatment consists of trickling filters followed by final settling, with the sludge from final settling returned through the plant. The sludge is digested in four digesters and dried on sand beds.

Over $1,400,000 were spent on enlarging the sewage treatment plant. $418,270 of this were in Federal funds. The plant is designed for a 1980-85 population of 70,000 people.

We believe that we have one of the finest and most up-to-date sewage treatment plants in the upper midwest. The treatment plant is operating efficiently and its effluent is meeting the standards which have been set for wastes being discharged into the Red River.

The Red River is by its very nature a warm, muddy, sluggish river. Water temperatures go over the 80-degree mark every summer. I do not believe that the Red River will ever be a good game fishing stream. This last statement is made as an ardent fisherman and not as a fisheries expert.

The Red River is rich in nutrients which support large algae growths both above and below Fargo. From our water treatment problems we know that runoff from agricultural lands contribute heavily to this type of nutrient problem. The month of September is a time of algae death in the river causing severe taste and odor problems in water treatment. We have just gone through one of these periods in our treatment plant. We know that every spring when the ice is out of the river and we get into the spring runoff that we will have coagulation problems at our water treatment plant. These problems are caused primarily by phosphates washed off of the fields and into the river by the spring rains. Agricultural fertilizers are contributing substantially to the load of phosphates and nitrates in the river.

It would be very interesting to know how much of the bacterial loading on the river actually comes from sources other than municipal or industrial, such as the washing down and cleaning off of farmyard barnlots and the very large duck populations in the Lake Traverse area.

Chlorination of the sewage treatment plant as recommended in this report would be an expensive additional burden on the citizens of Fargo, who have already spent over a million dollars of their own funds on pollution abatement, particularly if the main reason for doing this is to make for safer fishing in a stream of questionable fishing value.

In summary, it is our opinion that the City of Fargo is meeting and will continue to meet the standards set for pollution abatement in the Red River for biochemical oxygen-demand loadings and suspended solids loadings. Great progress has been made in North Dakota in pollution abatement in the Red River, and the North Dakota State Department of Health, the U. S. Public Health Service and the cities involved should be commended.

That is my statement.

CHAIRMAN STEIN: Thank you.

Are there any comments or questions? Just one second, and this is for information.

As I understood the Public Health Service report, they talked in terms of fishing during the winter in terms of ice fishing on the river, and they said that this was the time when the river was really hit by pollution. Now, I assume at that time you are not getting much runoff into the stream from the fields?

MR. RUBY: This is true. I missed your point, I think.

CHAIRMAN STEIN: The point is, you indicated that this wasn't a fishing stream and the implication and other point was how much of this was coming from runoff. I think, as I understood the Public Health Service statement or that portion of it that you seemed to at least agree with, that during the winter it was a stream for ice fishing and that if at that time the stream were being hurt the likelihood of that being caused by runoff from land was remote.

MR. RUBY: I think possibly I put my statement together badly. I meant to infer that it was not a prime fishing stream because of the warm temperature, slow stagnant movement and the silt load that the river does carry, which has no connection with the spring runoff, sir.

CHAIRMAN STEIN: Yes, I understand that. But it is a fishing stream during the winter, isn't it?

MR. RUBY: I have seen very little fishing in the stream in the Fargo-Moorhead area in the wintertime.

CHAIRMAN STEIN: That was the point I was trying to get at.

MR. SCHWANDT: The upper.

CHAIRMAN STEIN: The upper?

Thank you, sir.

Yes, sir.

MR. VAN HEUVELEN: Mayor Magnuson of Grand Forks has prepared a letter and directed it to the North Dakota State Department of Health. Mr. Al Forsman would like to read this letter to us.

Mr. Forsman. Mr. Forsman is Superintendent of the Water and Sewage Utilities in Grand Forks.

MR. FORSMAN: Chairman Stein, conferees, ladies and gentlemen.

This letter, as Mr. Van Heuvelen stated, was sent to him by Mayor Magnuson in answer to this call for this Conference.

"This is being written in response to the conference on pollution control of the Red River of the North and its tributaries.

"In August of 1962 the City of Grand Forks completed a three and two-tenths million dollar sewer improvement project for pollution control. Since that time sewage has been treated in our lagoon and has been returned to the river in a very satisfactory condition, according to reports that have been given to us.

"The industrial plants mentioned in the report have recently been taken into the City limits. We have only two (2) pieces of right-of-way left to obtain for the sewer lines and in connection with this intend to install two (2) additional lift stations. We expect to call for bids on this project as early as possible next year. It is estimated the cost will be approximately $130,000.

"With this improvement next spring together with what we have already done will mean that we can treat all of the sewage and industrial wastes from the City of Grand Forks.

"Yours truly, H. R. Magnuson, Mayor of Grand Forks, North Dakota."

CHAIRMAN STEIN: Thank you, sir.

Are there any comments or questions?

If not, thank you very much.

Mr. Van Heuvelen.

MR. VAN HEUVELEN: I might just add that the waste stabilization lagoon has done a very nice job for the City of Grand Forks.

We do have the mayor of one of our small towns on the main stem of the Red River, Pembina. It is the last community before the Red River goes into Canada. And Mayor Christopher is not only mayor of Pembina but he is also a State Representative.

Would you care to make a statement or just rise? Whichever you prefer, Mayor Christopher.

MR. CHRISTOPHER: I think they can hear me from here.

The City of Pembina is located at the lower end of the Pembina River at the confluence of the Pembina and the Red River of the North.

I might add, 10 years ago, realizing the importance of pollution control, the City of Pembina had a project for a lagoon system. With the Public Health Service aid and local bond issue we were able to construct a sizable lagoon, which we are very happy with.

On the American side of the border, there are three towns on the Pembina River. Walhalla, the largest city, is in the process of considering a lagoon, and I believe eventually they will have one, we hope. Neche, a smaller town, has a nice lagoon. And so you see, the towns along the Pembina River, recognizing the fact of pollution control, are making efforts to help out.

I feel that this is very important up in our end of the State, and in the Legislature, 1965 session, I was a little disappointed on the lack of interest for good legislation to assist the Health Department of the State to better control pollution control. I hope the next session will recognize the importance and we will get effective legislation to assist our State Health Department.

Thank you.

CHAIRMAN STEIN: Thank you, sir. Are there any comments or questions?

If not, Mr. Van Heuvelen?

MR. VAN HEUVELEN: We have one more. Mr. Martin, who is Manager of the Pillsbury plant at Grand Forks, wanted to make a brief statement, I believe.

Mr. Martin, by the way, the Pillsbury plant is one of our potato processers and is the kind of industry we like to see come into North Dakota.

Mr. Martin.

MR. MARTIN: Mr. Stein, members of the panel, ladies and gentlemen.

Since the time the Public Health Service study was made, the Pillsbury Company has put a clarifier into operation and is removing the settleable and floatable solids and are having these disposed of. The company is continuing in its program of developing further ways of reducing the material that is presently being discharged in the Red River of the North.

CHAIRMAN STEIN: Thank you, sir. Are there any comments or questions?

If not, thank you very much.

MR. VAN HEUVELEN: I would like to support that statement. We have had some very fine cooperation from the potato industry. They have quite a problem. It is a new industry in our State and we are actively working with them.

Thanks to the Public Health Service for demonstration grant funds which help us do the job. We do have a statewide committee made up of municipalities, industries, the university people and the State Health Department people all working on this problem, and I believe we are going to get it done.

CHAIRMAN STEIN: Thank you. Are there any other comments or questions?

MR. VAN HEUVELEN: As far as I know, Mr. Stein, that is everyone, unless there is someone in the audience.

CHAIRMAN STEIN: We will recess now. We are not cutting you off. If you want to resume after recess, you may. If not, we will go to Minnesota.

MR. VAN HEUVELEN: All right.

CHAIRMAN STEIN: Let us recess for ten minutes.

(RECESS)

CHAIRMAN STEIN: May we reconvene, please.

Mr. Van Heuvelen?

MR. VAN HEUVELEN: We have one more person that has to testify, Mr. Art Thoraldson, Grand Forks County Water Management and Control Board.

MR. THORALDSON: Mr. Chairman, ladies and gentlemen.

My name is Art Thoraldson. At present I am Chairman of the Grand Forks County Water Management and Control Board. As the Red River of the North is the boundary line of the eastern part of the county, it has great meanings for our Board. It also separates North Dakota from Minnesota, and thus creates problems that cannot be handled on a local or State level.

Our main concern now is the field of pollution on both sides of the Red River.

When you have two States, such as Minnesota and North Dakota, divided by this river, and both agricultural States, the problem is indeed of great importance to all.

Then, too, you have industrial wastes, such as from sugar beet plants, potato processing plants, municipal systems, and a great many other wastes brought into the stream or river by other means.

Pollution, like sin, is something no one talks about or cares to do anything about.

Now, with all the demand for clean water, it has created a movement that started some years ago. Under President Eisenhower, it started with a commission, then carried on by President Kennedy, and now President Johnson.

Recreation has entered the picture. The demand for water is greater than before. Fishing, boating, swimming, and so forth, are making such great strides that only available waters are taxed to their limits.

Now, what does this mean to us today? I believe that the warning is there, the time has come to act. Who shall be responsible for its control?

Pollution control or curtailment of one of our natural resources, Water.

Methods of reusing our water supply should be investigated.

Research should be stepped up so as to help prevent pollution of our rivers and streams.

The public should be more informed about pollution.

Yes, a mighty big program. Costs money too. But if we are to help the next generation do the things we have done and still enjoy our natural resources, it can be done.

The U.S. Public Health Service and the State Public Health Department should be the main governing bodies. They should have the power to enforce the laws, to recommend research, and to do all necessary duties in the field of pollution and its control.

And Mr. Chairman, I may state for the record that I am an amateur wildlife and conservationist now interested in the field of water.

CHAIRMAN STEIN: Thank you, Mr. Thoraldson, for a very thorough statement. Are there any comments or questions? If not, thank you very much.

Mr. Van Heuvelen?

MR. VAN HEUVELEN: That is it.

CHAIRMAN STEIN: That concludes North Dakota.

At the present time we would like to call on Minnesota.

MR. SCOTT: Mr. Chairman.

CHAIRMAN STEIN: Yes, sir.

MR. SCOTT: I am Vice Chairman of the Minnesota Water Pollution Control Commission. Commissioner Schwandt and I came out here to try to keep from being outnumbered by our North Dakota friends and the Federal Government. I don't think we succeeded, George.

But nevertheless, Mr. Lyle Smith is here, who is Executive Engineer for the Commission, and he will read a statement for the Minnesota Water Pollution Control Commission which has been prepared for presentation at this time.

CHAIRMAN STEIN: Mr. Scott, I took a quick count of the fans of the State, people here, and I don't think we are going to vote. (Laughter)

MR. SMITH: Mr. Chairman, conferees, ladies and gentlemen.

First I would request on behalf of the Commission that this statement and the attached Exhibits be a part of the record.*

CHAIRMAN STEIN: Without objection, this will be done.

MR. SMITH: The Commission welcomes the opportunity at a Conference of this type to present information to the public on the accomplishments, present conditions, policies, goals and objectives relating to water pollution control in Minnesota.

It is the understanding of the Commission that we are conferring here today on a question of interstate pollution which the Public Health Service was asked to investigate by Governor Rolvaag in February 1964, apparently at the urging of the Red River Basin Planning Committee. This Commission has not been aware of any serious pollution control issue between the States of Minnesota and North Dakota.

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* See Appendix IV.

The Public Health Service has investigated the matter and made a report on their investigation. A copy of their report, including recommendations, was received by the Commission on August 20, 1965. Our statements will in the main relate primarily to matters of concern and areas of interest as indicated in their report.

Specifically, we understand the area of interest to be comprised of the main stem of the Red River of the North from the Wahpeton-Breckenridge area to the United States-Canada border and tributaries which may affect the main stem. On the Minnesota side, these presumably include the Ottertail and Red Lake Rivers from their junctions with the Red River upstream through Fergus Falls and Crookston, respectively.

To provide some general background for better understanding of our current pollution control activities, we shall provide a brief history of the establishment of the Commission, the legal basis for control of pollution, and the situation as it existed in the Valley in 1945, which is the starting point for the Water Pollution Control Commission.

In 1945 the Minnesota Legislature enacted the Water Pollution Control Act (M.S. 115.01 - 115.09), which created a Water Pollution Control Commission charged with responsibility for enforcement of all water pollution laws of the State. The Water Pollution Control Commission was comprised of the heads of four state departments and one member-at-large, but was later enlarged to add two more members-at-large.

Incidentally, Mr. Scott, present here today, has been a member of the Commission since its formation in 1945.

All but two of the members of the Commission are appointed by the Governor. The Commission itself has no staff, but technical and administrative services the Commission might need in its enforcement of the Water Pollution Control Act are provided by the Minnesota Department of Health through the Section of Water Pollution Control. The Section devotes its entire resources and efforts to Water Pollution Control matters only and has a separate budget which is subject to the control of the Commission. The Chief of the Section is designated as the Executive Engineer of the Commission.

In 1963 the Legislature enacted Chapter 874, which further modified the Water Pollution Control Act to provide tools for more effective and aggressive control of pollution. The 1963 Act gave the Commission many new powers and duties, among which was a charge to classify all waters of the state and [illegible] standards of quality and purity as rapidly as practicable.

The Commission makes use of the power to classify and adopt standards to the fullest extent of its resources whenever it may be necessary to attain its objectives, but because of manpower limitations it has in the past relied mainly upon its powers to deny or revoke permits for sewage and waste disposal systems, and approve or deny approval of plans, and issue abatement orders if need be.

We believe the Legislature has, in the main, delegated ample authority to the Commission to carry out its stated policy in this field, to wit:

Section 115.42 of the Minnesota statutes is as follows:

"It is the policy of the State to provide for the prevention, control and abatement of pollution of all waters of the state, so far as feasible and practical, in furtherance of conservation of such waters and protection of the public health and in furtherance of the development of the economic welfare of the state. The Commission shall prepare a long-range plan and program for the effectuation of said policy, and shall make a report of progress thereon during each biennium to the legislature at the beginning of each regular session, with recommendations for action in furtherance of such program during the ensuing biennium. It is the purpose of Laws 1963, Chapter 874, to safeguard the waters of the state from pollution by: (a) preventing any new pollution; and (b) abating pollution existing when Law 1963, Chapter 874 becomes effective, under a program consistent with the declaration of the policy above stated."

A copy of the Long Range Plan and current program is offered as Exhibit 2 for the information of the conferees.

The Legislature has also provided explicit guidelines for the Commission in the exercise of its powers, as quoted below from Section 115.43:

"In exercising all such powers the commission shall give due consideration to the establishment, maintenance, operation and expansion of business, commerce, trade, industry, traffic and other economic factors and other material matters affecting the feasibility and practicability of any proposed action, including, but not limited to, the burden on a municipality of any tax which may result therefrom and shall take or provide for such action as may be reasonable, feasible, and practical under the circumstances."

Soon after its creation the Commission

established a system of permits for construction and operation of sewer systems, sewage treatment facilities, and industrial waste disposal works. Since 1945 no permit has been issued in this area for construction of any new sewer system without inclusion of appropriate treatment facilities, or for any waste disposal system for a new industry unless the treatment works were considered adequate to prevent or control pollution of the receiving waters. In addition, the Commission withheld permits for extensions of sewers in communities without adequate treatment facilities until satisfactory assurance was furnished that the community would provide such facilities within a reasonable time.

In 1945 in this area there were four municipalities discharging raw sewage (Breckenridge, Crookston, East Grand Forks and Halstad); three other communities (Fergus Falls, Moorhead and Wolverton) had inadequate treatment plants; and two major industries in East Grand Forks (American Crystal Sugar Company and King-O-Spuds) were discharging their wastes in nearly raw form.

It is estimated from our records that in 1945 the river at some times of the year was receiving, on an uncontrolled basis, oxygen-demanding wastes equivalent to a population as great as 168,000 out of a total raw amount equivalent to a population of about 200,000. In other words, only about 15 percent of the total B.O.D. (five-day biochemical oxygen demand) was being removed by treatment, and the remaining wastes were being discharged at their maximum rates in late winter at the very time when the assimilative capacity of the river is usually at its lowest. Tables 1 and 2 list these sources in more detail.

Table 1

Municipal Sewage Disposal in The Red River Area

Municipality	Year	Treatment Works	Raw PE (1) (2)	PE Discharged (1)
Breckenridge	1945	None	3,096	3,096
	1965	Tertiary (3)	8,200	400
Crookston	1945	None	7,679	7,679
	1965	Tertiary (3)	43,600	770*
Dilworth	1945	Secondary (4)	1,284	321
	1965	Secondary (4)	3,000	750
East Grand Forks	1945	None	6,285	6,285
	1954	Tertiary (3)	28,200	630*
Fergus Falls	1945	Secondary	18,736	13,100
	1965	Secondary	26,600	14,700*
Halstad	1945	None	722	722
	1965	None	750	750
Moorhead	1945	Secondary	18,955	5,690
	1965	Secondary	53,000	13,000*
Wolverton	1945	Primary	358	250
	1965	Primary	250	175
Totals	1945		57,115	37,143
	1965		163,600	31,175

(1) Estimated from Department records, except where marked by * which indicates data taken from Public Health Service report.

(2) Includes domestic and all connected industrial waste.

(3) Sewage stabilization ponds with over-winter storage are considered to be equivalent to tertiary treatment.

(4) Connected to Moorhead sewage treatment plant.

Table 2

Industrial Waste Disposal in The Red River Area (BOD Wastes)

Company and Location	Year	Treatment Works	Raw PE (1)	PE Discharge (1)
American Crystal Sugar Company, Crookston	1945	Mill not in operation		
	1965	Storage ponds	204,000	102,000
American Crystal Sugar Company, East Grand Forks	1945	Settling pond	105,000	105,000
	1965	Storage ponds	154,000	77,000
American Crystal Sugar Company, Moorhead	1945	Mill not in operation		
	1965	Storage ponds	204,000	102,000
King-O-Spuds, Inc., (Formerly Potato Products Company), East Grand Forks	1945	Screens	38,000	26,000
	1965	Screens and connection to city system		
Totals	1945		143,000	131,000
	1965		600,000	281,000

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(1) Estimated from Department records (for beet wastes on basis of 8.3 lb. BOD/ton of beets sliced and 50 per cent reduction by storage found in 1949-1951 studies made by this Department at Moorhead mill).

The Commission at a very early date clearly recognized its responsibilities to its neighbor states and to other agencies concerned with water resources management, and made agreements and promulgated policies designed to aid in the attainment of our common objectives. We refer here to specific agreements made with the State of North Dakota in July 1945, and August 1949, and the United States Secretary of War in September 1947; and endorsement of the policies of the Missouri Basin Health Council to which the Secretary and Executive Officer of the State Board of Health (who is a member of the Commission) subscribed; and the stated policy of the Commission relating to low flow augmentation. Copies of these agreements and policy statements will be found in Appendix IV.

All of these have direct application to this area. We would like to summarize them briefly as follows:

In 1945 the Commission approved the Interstate Sanitation Committee agreement.

In 1947 the Commission, at the request of the Red Lake Drainage and Conservancy District, furnished the Secretary of War with the assurance that certain conditions would be complied with, resolved to undertake, agreed and assured the Secretary of War that it would:

1. Control the contamination of Red Lake, Clearwater and Thief Rivers by rural areas and villages without sewer systems;

2. Require that municipalities which discharge sewage into Red Lake, Clearwater or Thief Rivers treat their sewage before discharge into the streams so as to effect a reduction in the biochemical oxygen demand of not less than 85 percent for towns of 1,000 population or greater; and of 35 percent for municipalities having a population less than 1,000.

In 1949 the Commission declared the following policy regarding water pollution control in the Red River of the North and tributaries and adopted the following general standards for treatment of municipal sewage and industrial wastes discharged into the Red River of the North as recommended by the Interstate Sanitation Committee:

That industry and municipalities treat their wastes to the point where the average daily composite 20° C, five-day B.O.D. is 25 parts per million, suspended solids 30 parts per million, with no peaks running over 50 parts per million, 20° C, five-day B.O.D. and 60 parts per million suspended solids.

Chlorination shall not be used as a means of obtaining these B.O.D. reductions, although it may be required for other purposes. Certain types of industrial wastes such as those resulting from the processing of agricultural products may have to be considered on an entirely different basis.

There were several of the conditions to be met for authorization of the Red Lake - Clearwater River Flood Control Project under the Federal Flood Control Act.

Bearing in mind then the situation as it existed in 1945, we would like now to call your attention to the progress made in installing sewage and waste disposal works from that time up to the present, as follows:

Chronology of Major
Sewage and Industrial Waste Disposal Works
Constructed Since 1945 in the Area of Concern

(Includes only direct discharges to the main stem or near the main stem on major tributaries so as to affect the main stem.)

Year	Municipality or Company	Project
1947	American Crystal Sugar Co., Moorhead	Storage ponds and lime sludge ponds
1950	American Crystal Sugar Co., Moorhead	Additional storage capacity
1951	Moorhead	Addition to biological filter plant
1954	American Crystal Sugar Co., Crookston	Storage ponds and lime sludge pond
1956	Breckenridge	Stabilization ponds
1957	Ottertail Power Co., Hoot Lake Station, Fergus Falls	Cooling tower
1959	Crookston	Stabilization ponds
1960	East Grand Forks Fergus Falls	Stabilization ponds Biological filter plant
1961	American Crystal Sugar Co., East Grand Forks	Storage ponds

of this total only about 281,000 PE is actually discharged because about 50 percent of the B.O.D. is removed by treatment. The remainder of this waste is discharged only under control, including monitoring of the rivers, during the ice-free fall period and in the spring flush when there are usually ample oxygen resources to assimilate the wastes without significant harm to fish, wildlife or other uses of the rivers.

In contrast to the 1945 situation, there are now no industrial discharges to the river under ice cover during the critical winter period by reason of the large storage ponds which have been provided, even though at that time mill processing may be at maximum rates. The extensive construction of municipal sewage stabilization ponds has served the same purpose and by their use treated sewage discharges during this critical winter period of ice cover now amount to only about 29,000 PE.

In summary, the total raw PE from both municipal and industrial sources at this critical time of the year now amounts to almost 760,000 compared to 200,000 in 1945, thus having undergone almost a four-fold increase, but the net discharges under ice cover now is only 29,000 PE compared with 168,000 PE then. On an over-all basis, for this most critical time of the year the effective decrease in B.O.D. discharges accomplished by a combination of treatment and transfer of discharge in time to the more propitious period of the spring flush, amounts to an astonishing 96 percent. It is estimated that the municipal improvements cost about $2,800,000 and the industrial works cost about $1,300,000 for a total of somewhat more than $4,100,000.

This we submit is an accomplishment worthy of respect.

We call specific attention to the development and use of ponds in this area which provide a most valuable tool for control of pollution that are deserving of enlightened and intelligent use by the regulatory authorities. It is hardly possible, for example, for conventional treatment works as we know them to approach this figure on a routine day in-day out basis, but, in fact, the full gorwth potential of this area cannot be realized unless such figures become routine and are exceeded in the future. We believe it can be done, but only by employing a reasonable mixture of treatment of sewage and wastes to the degree necessary and practical, plus storage and effective discharge control of all effluents or residual wastes, and low flow augmentation where applicable.

In addition to the disposal works already constructed, which are discussed above, there also are several other substantial projects for which planning was started some time ago

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and which are now progressing through the various necessary stages of engineering and financing. Most of these are fairly certain to be constructed in the near future. These projects are as follows:

Sewage and Industrial Waste Disposal Works Currently Underway or Being Planned in the Red River Area (Includes only main stem and major tributary sources)

Municipality or Company	Project
Moorhead	Activated sludge plant addition
Halstad	Stabilization ponds
Crookston	Aeration of stabilization ponds, and segregation and reduction of industrial wastes
American Crystal Sugar Company, East Grand Forks	Recirculation or additional storage to provide better control of releases.
Wolverton	Stabilization ponds

It appeared to us on the basis of the accepted standards mentioned previously that with completion of these projects as planned the major sewage disposal needs in this area in regard to the B.O.D. from existing sources would be fairly well satisfied for the time being. However, there are also other pollution control objectives to be considered which were apparently used as a basis for some of the recommendations made in the Public Health Service investigation report.

We believe that the best uses of these waters are now, and in the main will continue into the aforeseeable future to be largely confined to domestic and industrial water supply. Except for the two small villages of Halstad and Wolverton, all of the municipalities and industries mentioned by name in this statement as sources of sewage or wastes also depend upon these rivers for their water supplies. In every case with the exception of the Village of Oslo where a municipality is using the river as a raw water source it operates a complete water treatment plant to purify the water for its citizens, as well as operating sewage disposal works to avoid harming its downstream neighbors. Olso has no municipal sanitary sewer system.

The use of the river for other purposes is quite small in proportion. Some occasional stock watering and irrigation are done and there is only limited recreational use in this area, primarily because of the unsuitable physical nature of the stream. Dr. John B. Moyle, Supervisor of the Section of Research and Planning, Minnesota Department of Conservation, in a letter to Mr. Kenneth Mackenthun, Biologist, U. S. Public Health Service, Cincinnati, dated June 9, 1965, was stated: "These streams support some sport fishing, especially below dams and in the vicinity of cities and towns, and this fishing could be expected to improve somewhat by cleaning up of pollution in these rivers. It should be pointed out, however, that because of the physical nature of these streams they cannot be expected to ever be highly productive fishing waters, either for game or commercial fish. They can be expected, however, to provide some local sport fishing."

The mainstay of the area is agriculture and agriculturally oriented industries. The soil constitutes the primary resource of the region. The only obvious major growth potential lies in the expansion of agriculture and processing of agricultural products. This has been vividly demonstrated in the last two decades by the expansion of the beet sugar industry which has already been mentioned, and is, hopefully, also becoming evident in the potato processing field.

Along with this growth have come waste disposal problems, which we feel have been faced squarely. Treatment facilities have been constructed and operated in keeping with good engineering practices, and the intent of the Water Pollution Control Act has been followed both in regard to protecting the waters of the state and in giving due consideration to the growth and expansion of the economy of the state.

The growth of the economy of this area is completely dependent upon these rivers for water supply, and also dependent upon them for disposal of waste effluents. This economic growth can be stifled, as we all realize, by a shortage of water, unless reasonable and practicable waste disposal requirements are followed by those in authority.

The following programs which have a bearing on the report of the Public Health Service are under way:

a. The City of Moorhead has made application for and received a grant offer under the Federal Water Pollution Control Act and must award a contract for additional sewage treatment facilities by December 1, 1965, in order to comply with conditions of the grant offer.

b. The Village of Halstad has plans for sewage treatment facilities approved by the Commission and has made application for a grant under the Federal Accelerated Public Works Act.

c. The Commission temporarily suspended the requirement for construction of improvements to the City of Crookston sewage treatment facilities under the conditions:

  1. That the city submit monthly records of pond operation to the Commission and that these records include daily measurements of overflow from each of the ponds and weekly chemical and biochemical analyses of samples of pond overflow.

  2. That pond operation be controlled such that no overflow is permitted during periods when the five-day biochemical oxygen demand of the secondary pond effluent is greater than about 25 milligrams per liter.

d. The American Crystal Sugar Company plant at East Grand Forks has made a commitment to use sodium nitrate for odor control in their storage ponds if a serious odor problem develops in the event wastes must be held over a summer period and to provide facilities for recirculation of the stored waste if necessary.

e. The Village of Wolverton has completed a preliminary engineering report but has not as yet authorized consulting engineers to prepare final plans and specifications for sewage treatment facilities.

f. The Commission is reviewing its policy and procedures for the classification and adoption of standards for the waters of the state and is proceeding as rapidly as manpower permits to adopt classifications and standards for which the Red River will receive an early priority.

g. Plans for chlorination are included in the proposed treatment plant expansion for Moorhead and in recently constructed additions at Fergus Falls and year around chlorination can be provided. Further study is necessary to determine the need for chlorination of the stabilization pond overflows.

h. While it appears at this time to be questionable as to whether maintaining 5 milligrams per liter of dissolved oxygen at all times is essential, if we are to adopt this higher standard it will take additional time to accomplish.

i. The implied requirement of possible chlorination of beet sugar wastes is not supported by sufficient information on the public health significance of the coliform count reported. Because of the volume and characteristics of wastes additional information is necessary to justify the costs involved.

In order to avoid duplication of effort and possible confusion from recommendations which may be made by the International Joint Commission these proceedings and conclusions should be made available to them with the request that the International Joint Commission study include: (a) the effects of the proposed Garrison Diversion project with respect to pollutional problems, (b) the possibility for better low flow augmentation by existing or potential reservoir releases after all municipalities in the area have provided waste treatment up to the specified 90 percent or equivalent.

The Water Pollution Control Commission will continue to work toward effective pollution control and will cooperate with all agencies concerned.

Thank you, Mr. Chairman.

CHAIRMAN STEIN: Thank you, Mr. Smith. Are there any comments or questions?

Thank you very much, sir.

As usual, Minnesota has given a complete description of its program and made its points very clear.

Do you have any other?

MR. SMITH: I have only one specifically. I would like to go down the list very early, if I could.

CHAIRMAN STEIN: Surely. And while you are going down the list, let us think of this procedure. I think we can complete today, but I think the better part of discretion, even though we are pushing ahead, is after we are completed here before we get in the final door we take another ten-minute recess before we start. I found on the basis of long experience that when we stretch this too hard, we may just be a little testy and we all might say things we don't like to say, and a break might help.

So I would suggest that we consider that, just take a ten-minute recess. I think this will get us out of here more rapidly in the long run.

Go ahead, Mr. Smith.

MR. SMITH: Are there any State Legislators present who would wish to make a statement?

Are there any State agencies present represented that would like to make a statement?

Then I would like to go down the streams, first taking the Ottertail River. Is there anyone from Fergus Falls that desires to make a statement? Mr. Sowden.

MR. SOWDEN: Mr. Chairman, members of the panel, ladies and gentlemen.

I have no prepared statement. However, I would like to make a couple of comments.

The City of Fergus Falls has the enviable condition in that we have the first use of water on the Ottertail River and you might say the largest volume of the Red River of the North. Now, recognizing the fact that we have an extremely pure water to treat in our water treatment plant, the City of Fergus Falls is making every effort to see that we send the water out from our sewage disposal plant as clean as we possibly can. At the time of the survey in 1964, we were having a great deal of trouble with one of our lift stations, which, by the way, we are now in the process of rebuilding and will have the problem eliminated. In other words, we were causing a large amount of sewage to go directly into the stream.

Another problem that we were encountering was that the National Tea Co. packing plant was sending all of their blood into our sewage treatment plant, causing a great deal of difficulty in our treatment. They have now eliminated all of their blood from coming into the plant. We have increased the efficiency of the plant to a full 90 percent B.O.D. removal.

We have the facilities for chlorination of our effluent.

Mr. Chairman, I again state that the City of Fergus Falls wishes to assure you that we intend to send our effluent into the stream as fully treated as possible.

Thank you.

CHAIRMAN STEIN: Thank you, Mr. Sowden.

I understand that the plant is a secondary treatment plant.

MR. SMITH: This is correct.

CHAIRMAN STEIN: And the paunch manure is removed by the packers before it gets to the plant?

MR. SMITH: This is right.

CHAIRMAN STEIN: We consider that as good practice. It doesn't always obtain, as you may know.

Are there any further questions or comments?

Mr. Smith.

MR. SMITH: I would like to take the Red Lake River. Is there anyone here from Crookston or from East Grand Forks that wishes to make a statement?

I would like to take then the main stem of the Red River. Is there anyone here from Breckenridge? Wolverton?

The Mayor of Moorhead is here. Would you care to make a statement?

MAYOR STORDAHL: Not at this time.

MR. SMITH: Halstad? Oslo?

I should like to go, then, to the industries. The first on my list is the Ottertail Powder Company. Mr. Cowles, do you wish to make a statement?

MR. COWLES: No, sir.

MR. SMITH: The next would be the American Crystal Sugar Company, Mr. Porterfield.

MR. PORTERFIELD: Mr. Stein, conferees, ladies and gentlemen.

Before I read this short statement, I would like to commend the U.S. Public Health Service for this study they have made on this long stretch of river. In this study, they have found that the American Crystal Sugar Company is a polluter and I have a few remarks to make in regard to that. I think first that I will read this short statement which I have given the reporter.

Beginning with the year 1954 the American Crystal Sugar Company has had three operating beet sugar plants in the Red River Valley. Our new plant located at Drayton, North Dakota, will start its first operation about September 22, 1965.

The East Grand Forks plant was constructed in 1926. Waste water disposal at that time was not regulated by Federal or State Agency. Prior to the construction of the plant at Moorhead, Minnesota, application was made to and approval was granted by the State of Minnesota for the ponding and controlled discharge of waste water. The same procedure was followed prior to the construction and operation of the Crookston, Minnesota, plant in 1954. Ponding facilities were constructed at East Grand Forks in 1961, at which time controlled waste water discharge was instituted.

Our waste water discharge has been according to the conditions set forth in the original permit to Moorhead in that the dissolved oxygen of the water in the river below the plant waste outlet would not fall below 3.0 parts per million. We have maintained close checks on the conditions of the river water both above and below our plants.

From review of the U. S. Public Health Service Report on the pollution of the Red River of the North it would appear that the proposed basis of control for waste water discharge be that to maintain a minimum of 5 parts per million of dissolved oxygen along all segments of the Red and Red Lake Rivers from Moorhead and Crookston to the International boundary. With this control there is indicated to be little, if any, allowable discharge at Moorhead, and but nominal amounts from Crookston. East Grand Forks and Drayton probably will not be significantly affected.

On inspection of Chart and Table A-5 we can conclude that to maintain the standard 5 parts per million D.O. below our point of discharge and also Fargo - Moorhead, the Moorhead plant cannot discharge waste water at any time when the river flow is less than 190 cubic feet a second at 7.5 degrees Centigrade, 310 cubic feet a second at 12 degrees Centigrade or 520 cubic feet a second at 18 degrees Centigrade.

Assuming that the United States Public Health Service has made a fair estimate of the B.O.D. loading, and that the river can assimilate 556,500 pounds of B.O.D. for the maintenance of 5 parts per million dissolved oxygen, by difference than Moorhead must reduce the pounds of B.O.D. up and above any current reduction across and through the ponds by 1,243,500 pounds or

69 percent.

Vastly improved river flow over that of last season will be required if any water other than that of the ash flume, which amounts to about .25 million gallons at 25 parts per million B.O.D., is to be discharged. Only improvement in the two municipal systems will allow for greater quantities.

The practice of discharging cleanup water at Moorhead will be stopped. Further investigation will be conducted at Moorhead and Crookston to determine and eliminate the high fecal coli source.

All of the major beet sugar companies are contributing additional money to a Federal grant for Waste Water Research work presently under study at the Holly Sugar Corporation plant at Tracy, California. The American Crystal Sugar Company will continue to study and try to improve the quality of our waste water discharge.

That is the end of the statement. Now, I have two or three things I would like to mention.

I talked to Mr. Smith earlier in the day and this as regards to the high fecal coli count at Moorhead and Crookston. He said they were worried about trying to figure why this would happen. We think maybe we can shed some light on that.

For several years, we have been experimenting and the experimentation was first started at Moorhead whereby we were adding enzymes to our pond to try to create bacterial action which would in turn use up some of the sugar in the ponds and give us a better dissolved oxygen discharge. A few years ago, I had a bacteriologist tell me, he said, "Let me examine those enzymes you are using and I will see if I can give you a recommendation."

I soon after got a report from him and he said, "I believe you might just as well use Milorganite." So we decided that we would use the enzymes at Moorhead and we would use Milorganite at Crookston.

Last year we decided if this was the way to go that we would try some activated sewage sludge, and we did this. We obtained 500 gallons of activated sewage sludge from the Moorhead municipal plant and we added that to our pond at Moorhead.

Maybe we are wrong in this approach. We thought we were creating a better atmosphere for bacterial action.

Maybe we have actually contaminated our ponds rather than made a beneficial application.

We at Moorhead do have a septic tank system for our domestic waste. There have been times when the weather has been on the subzero side when our discharge pipe has frozen and the overflow from the septic tank has been turned into our pond. We expect to correct that this year.

At our Crookston, Minnesota, plant we have an Imhoff treatment system, and after reading the Department report, we are of the opinion that our chlorination system probably has not been working properly. We will try to correct this condition at Moorhead and Crookston this year.

I have just one more short thing that I would like to read into the record. The National Technical Task Committee on Industrial Wastes, an industry group formed to advise and inform the Department of Health, Education, and Welfare on water matters pertaining to industry, has attempted to get Congress to pass a bill which would give industries tax relief from the cost of making waste treatment installations. This has been looked upon favorably by many Congressmen and Senators and it is hoped that some action will soon be taken. Since the Federal Government is giving aid to municipalities that are building treatment plants, it would seem most logical that industries be given some of the same kind of relief from expenditures that can in no way return any earnings on the investment.

Thank you.

CHAIRMAN STEIN: Thank you, Mr. Porterfield, for an excellent statement.

Are there any comments or questions?

I think you ought to be commended for your candor in setting these facts forth, and I do say that if we have a full exchange of views like this with industries, I don't anticipate very much trouble.

On the other end, I can give you a report on that tax relief. As you know, this has been around Congress, oh, since I can remember, coming back from the war, since '48, at least. The bill has never, and I say again never, had a hearing before the Finance Committee or the Ways and Means Committee, the Finance Committee of the Senate, the Ways and Means Committee of the House. In all administrations, and I have been with the Government for over 23 years, whether it has been the Truman administration, the Eisenhower administration, the Kennedy administration, Republican or Democrat, the Treasury Department has been implacably opposed to this kind of legislation. The last time Senator Ribicoff tried to get this out of the Committee and he failed. I am not sure of the votes here, and I would like to get off the record because I may be mistaken.

(Off the record.)

I do think you have a good point with industry and what industry is doing, but again I think we have to be realistic and look at the facts as they are and as they are going to be in the future. The assumption we are proceeding under is where legislation is under way for municipal grants to be increased, I think that will be forthcoming rather rapidly, we have to make the assumption, at least for the present, although the administration has never come out with comprehensive proposals in this field yet and we have to wait and see what they are going to do, this is under study, but we have to proceed under the assumption that there probably will not be any Federal financial aid for industry as yet. And, of course, as you have seen here, many of the industries here have gone into municipal waste treatment plants. In effect, this is a Federal subsidy to industry, because 30 percent of that plant, if you can possibly go into a municipal plant, can be handled by a Federal grant.

I don't know that that is much solace for the sugar beet industry or an industry such as the pulp and paper industry and the iron industry or iron and steel industry. Some of these industries have very large amounts of wastes and the pulp and paper industry in particular has a relatively short season and this would require a municipal plant to put in all these facilities which would only be used during the campaign. So this presents some very, very special problems and we recognize this.

But I think we have to try to get our program moving ahead taking that into account.

MR. PORTERFIELD: Well, we are getting a little Federal help on this plan instituted at Tracy, California, now.

CHAIRMAN STEIN: Yes. Well, as you know, we will be happy to cooperate as much as we can, particularly with industries having a particular problem like yours on waste treatment. Although again, and this may be on the other side, I think you have to recognize again and understand the intimate nature of the discharge. But in modern pulp and paper plants they are achieving a considerable reduction in the wastes, even in lagooning. Now, whether this is feasible for sugar beet wastes, we don't know.

MR. PORTERFIELD: Sugar beet waste in this area, of course, becomes a greater problem then in other parts of the country because we do have severe subzero weather. For quite a period of storage time we have ice cover on the ponds, we get no action.

CHAIRMAN STEIN: Again I think this is fairly characteristic of a large part of the sugar growing industry.

MR. PORTERFIELD: It is more so here than in any other part of the country.

CHAIRMAN STEIN: Than some other parts.

Are there any other questions or comments?

By the way, I can understand your view and I am sorry the rules don't permit when that 5 parts per million was broached in view of the problem you have.

MR. PORTERFIELD: I did ask the question.

CHAIRMAN STEIN: You are right. Yes, sir. Thank you very much.

MR. CLARE: I just have one comment. Mr. Smith referred to the use of information from our study and from this conference by the International Joint Commission. As a member of the Advisory Board which has been appointed to study the pollution of the international waters of the Red River of the North, I can state that it is the expressed intention of the Board to avoid all duplication possible and to make all information available to the Board. So this will be done.

I have one other. I find there is another Federal representative here who has not been introduced and I should like to do this for the record. Mr. Nels Snustad is here. He is the Area Conservationist for the Soil Conservation Service at Fergus Falls representing the Minnesota State Conservationists.

Mr. Snustad we are glad to have you with us, sir.

CHAIRMAN STEIN: Mr. Smith

MR. SMITH: Are there any civic organizations, sportsmen's groups, or conservation groups represented here, anyone who would wish to make a statement?

I do have a request from Mrs. G. E. Mann, Chairman of the Water Resources Committee of the League of Women Voters, for permission to submit a statement, Mr. Stein. She does not have it here. In fact, I don't believe she is in the room now. I don't know what your policy is.

CHAIRMAN STEIN: Without objection, we will keep the record open a week and if she gets it in to Mr. Clare or Mrs. Rankin, that will be included.

(Which said statement is as follows:)

Statement prepared for the Conference on Pollution
of the Interstate Waters of the Red River of the North
at Fargo, North Dakota, September 14, 1965 - by
Mrs. G. E. Mann, Water Resources Chairman,
League of Women Voters of Minnesota

Chairman, conferees, the League of Women Voters of Minnesota welcomes the opportunity to express their interest in the water resources of their state.

The Red River Basin has provided a basis for study that brought together women from Leagues in North Dakota and Minnesota. We became aware of the importance of water to this area. The boundary line did not divide the water but did allow for different interpretations of water use and water rights. League members concluded that a Red River Planning Commission would provide the means of communication between North Dakota and Minnesota. We have observed the progress of this Planning Commission with interest.

League members will be reviewing what has happened in the Red River Basin since their study was published in 1959. In Minnesota, there is a League in Fergus Falls, Battle Lake, Moorhead, and a provisional League in Crookston. The three largest towns are located on the Otter Tail River, Red River and Red Lake River. These towns have been increasing in population in an out-migration area. They are interested in developing economic opportunities in this basin just as they are in North Dakota. Water resources is a vital key to the success of their planning.

We have been concerned when we hear of untreated sewage entering rivers that provide a water supply for towns downstream. We have been concerned when the Orwell Dam released water to supplement the downstream flow of the Red River. We have been concerned about the dangers of flooding in the Red River Valley. We have been concerned about industrial pollution that is allowed in order to keep the industry. We have been concerned about pollution of our lakes.

A form of action taken by the Leagues in Battle Lake and Fergus Falls was to work with other groups for a county planning commission. One of the main reasons the Board of Commissioners established this commission was because of the growing threat of pollution to the lakes of Otter Tail County.

For several years, the Leagues in the Red River Basin have been invited to meet with other organizations at the Crookston Winter Show for a seminar on Water Resources. Farmers, businessmen, Government representatives and homemakers exchange information, questions and ideas about this natural resource. It is this challenge of understanding the importance of water to this region, the many problems and conflict of interests as well as what can be done that must be met by the citizen.

Information such as the Report of the Red River that was received today will help guide future decisions as informed citizens work to provide a safe and usable water supply adequate for the needs of the people of the Red River Basin.

MR. SMITH: Are there any individuals who wish to make a statement not representing any particular organization?

We have nothing else.

CHAIRMAN STEIN: I think the thing to do now is to recess for ten minutes and see if we can conclude.

(RECESS)

CHAIRMAN STEIN: May we reconvene.

Let's see if we can--

MR. SMITH: Mr. Stein, may I introduce one person?

CHAIRMAN STEIN: Yes.

MR. SMITH: Mr. Frank L. Woodward, State Sanitary Engineer, Director, Division of Environmental Health of the Minnesota State Department of Health.

MR. WOODWARD: Mr. Stein, Conferees.

I had a written statement I intended to introduce, but I was naive enough to think that this matter of five parts a million wouldn't be brought up until I got a chance to say something. This has been pretty well explored by now.

There is one other thing before I talk about the five parts per million of dissolved oxygen. In the Public Health Service Report in listing the communities that use the waters of the basin of the main stem of the river, at least, for domestic purposes, the City of Moorhead was omitted. Perhaps that is why Moorhead didn't see fit to say something here. But up until a few years ago, Moorhead's water all came from ground water sources, from wells, but as people in this area know, this is a pretty limited source of water and with the heavy growth of Moorhead it became necessary to obtain water from the Red River, and so Moorhead gets a large part of its domestic supply now from the Red River.

I don't like to beat this five parts a million item too much, but I think it might be one of the outcomes of this Conference that maybe five parts per million is established as the minimum dissolved oxygen under whatever conditions may be set up that should be provided in the Red River, but I want to insist that this is not a standard that has been accepted and adopted by the Minnesota Water Pollution Control Agency. It was taken, apparently, from the statement agreed upon by the members of the engineering section of the Missouri Basin Health Council, which is now the Missouri Basin Engineering Health Council, of which I have been a member since 1950, and I think I am the one one in the room who was a member at that time. Mr. Van Heuvelen is now in that position, but he was not on the Council at the time that these objectives were adopted.

It was very clear to the members of the Missouri Basin Health Council that the objectives were set for the Missouri Basin, and so far as I know, the Red River is not considered a part of the Missouri Basin. It wasn't, at least, in our thinking at that time.

And also it points up that five parts per million relates to conditions to be provided when other conditions are suitable for fish habitat, and this may be the point that this Conference should determine, whether or not certain species of fish are to be protected.

I think this is all I have to say about this, but I wanted to clear the air of this assumption that this standard had been adopted by the State of Minnesota and by the State of North Dakota, which is in error. I think the time to adopt a standard may be beginning now.

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CHAIRMAN STEIN: You know, Frank, reading this--and I don't want to make any apologies because I didn't write this report.

MR. WOODWARD: I know you didn't.

CHAIRMAN STEIN: But I don't think they said that. I am not saying that what they said was said in the most felicitous way. I want to back my people up. What they said was this, and I hope we are not going to get too technical in the literary sense. They say,

"The recommendations with regard to dissolved oxygen are based on the standard of 5 milligrams per liter of the Missouri Basin Health Council, to which both States subscribe."

Now, "to which both States subscribe" goes to the last preceding antecedent, which is the Missouri Health Council, not the five parts per million, and I don't know if the implication was that, but I think that is what these fellows wrote.

MR. WOODWARD: I wanted to get a little sarcastic and put that in my written statement, and I didn't know which of these phrases connected with the--

CHAIRMAN STEIN: Yes. But presumably that is what they meant.

MR. WOODWARD: But nevertheless, the five parts a million is picked up from somewhere and it is evidently here and it is indicated that it is a standard of the states. I, as a matter of fact, have no authority to commit the State Water Pollution Control Commission of Minnesota to any standard. I am not in the chain of command in that respect. I might want to urge them sometimes, but you should see how some of my urgings come out. (Laughter)

CHAIRMAN STEIN: Let me point out, you know, this is what you find and this is from Mr. Smith's statement, he says,

"The principal guideline" and so forth "was to maintain always a minimum dissolved oxygen content in the streams of at least 3 milligrams per liter."

And now this is a guideline. The next sentence says,

"The latter has been used as an informal stream standard by both States for many years."

I don't know if we really even have three. As I read this, we have nothing.

MR. WOODWARD: I am not arguing this.

CHAIRMAN STEIN: Yes.

MR. WOODWARD: I think this is the point, that if we are going to bring about conditions we want in the Red River and tributaries, we start from here and work with what we have already and try to bring about what we want.

CHAIRMAN STEIN: Right. Thank you.

Are there any other comments or questions?

Mr. Smith, do you have anything further?

MR. SMITH: No.

CHAIRMAN STEIN: If not, let us go on. I think the issue has been clarified and let's see how close we come in any event.

I would like to, if we could, first meet the statutory requirements of the summary. One, is occurrence of pollution subject to abatement under the Federal Act? Two, what is the adequacy of remedial measures and the nature of delays?

I think we could say that the Red River of the North is an interstate river within the meaning of the Federal Act. I don't know that there can be any dispute about that.

The next point, I think, in this goes in terms of the report that pollution of the Red River of the North from industrial and municipal sources in both Minnesota and North Dakota creates conditions of pollution which create a hazard to health in water contact sports, deleteriously affects water supply, deleteriously affects fish and aquatic life, and deleteriously affects recreation.

Is that a fair statement?

The third point, I think, in the adequacy of remedial measures and nature of delays, that cognizance must be taken of the very active program in both states in dealing with pollution control in this river. I think we should take cognizance of the fact that we are not dealing with a situation where you have just rampant raw discharges, but you have treatment in most of the cases. Certainly most of the large industries and the large municipalities here have treatment. The problem is caused by the extreme technical difficulties of the problem and the fluctuations in the flow of the Red River and the fact that you have a growing population and growing industry and you have a very limited water resource in which to discharge your wastes.

I think we can agree possibly on those three as a statement at the beginning of the Act.

Now, I do think that we can start with the requirements of both states, and I don't know if these are recommendations or standards. They are listed as both. But I think the next point can be that as a point for departure industry and municipalities treat their wastes to the point where the average daily composite 20 degree Centigrade five-day B.O.D. is 25 parts per million, suspended solids 30 parts per million, with no peaks running over 50 parts per million 20 degree Centigrade five-day B.O.D. and 60 parts per million suspended solids, that chlorination shall not be used as a means of obtaining these B.O.D. reductions, although it may be required for other purposes, and that certain types of industrial wastes, such as those resulting from the processing of agricultural products, may have to be considered on an entirely different basis.

I think this has been adopted by both states and very well can become the basis of agreement from where we can go.

Let us see if we can operate here with the recommendations made in the report and see how much agreement we can get at, and I am reading from Page 10, gentlemen, of the Public Health Service report.

One, the first one, reduction of the waste load from the municipal treatment plants at Fargo and Moorhead will be required whenever flow is less than 80 cfs in the summer and less than 60 cfs in the fall.

Is this agreeable?

MR. SMITH: I don't understand it. Reduction below what? Below the present B.O.D. low?

CHAIRMAN STEIN: Well, I think what this--that is a generalized statement. Let's go down to No. 2.

MR. VAN HEUVELEN: It covers the same thing, but they are different.

CHAIRMAN STEIN: What?

MR. VAN HEUVELEN: They are a little bit different.

CHAIRMAN STEIN: Well, No. 2 is specific, I think. Let's see if we can come to agreement under the areas where I think we do have agreement.

Can we agree that no industry will discharge its wastes under ice cover?

MR. CLARE: By this you mean a separate industrial outfall?

CHAIRMAN STEIN: Separate outfall, not to municipal system. I think as I heard it, at least, unless I am mistaken, this was the policy of both the states. Is this correct? Or do you want to take them up one at a time?

MR. SMITH: Well, this has been the policy in the sugar beet wastes, certainly. I don't know whether you would say all industry. I think it would depend upon what might come into the valley and what type of wastes they may have.

CHAIRMAN STEIN: All right. Let's talk about the industries named in the report.

MR. SMITH: Yes, this--

CHAIRMAN STEIN: The industries named in the report, and this includes the sugar beet industries, is this correct?

MR. SMITH: Yes.

CHAIRMAN STEIN: The industries named in the report having separate systems.

MR. VAN HEUVELEN: Yes.

CHAIRMAN STEIN: All right.

MR. VAN HEUVELEN: I think we would buy that, because I think we started more or less treating wastes in waste stabilization lagoons. I would hate to see us adopt a broad, sweeping statement that no industry in the future would do this, because we don't know what we have coming. But if we are talking about sugar beet and potato processing, I think we can buy that.

CHAIRMAN STEIN: Yes. That would include the same kind of industry if you got a similar new sugar beet plant or potato processing plant, the same restriction would hold, no discharge of wastes under ice cover. Is that a fair statement?

MR. PETERSON: Mr. Stein, if something came up and the industry found a method to treat its waste adequately and satisfactorily and even, say, better than a municipality, say they got 98 percent treatment, are you still going to stop discharge of wastes under ice?

CHAIRMAN STEIN: I don't think so. But when anything else new--and this applies to any one of these things, we talk in terms of lagoons, primary or secondary treatment. If something new comes up--I think anything we say here assumes existing conditions and no breakthrough.

And again let me try to get away from this and go off the record.

(Off the record.)

CHAIRMAN STEIN: I think underlying all these, if a new industry or new process comes in, we may all be sure we will be delighted to change it. This goes for municipal wastes as well.

Now, would you agree on No. 2, that the combined waste load from the municipal waste treatment plants at Fargo and Moorhead should not exceed 2800 pounds a day of ultimate B.O.D. and apportioning this load on a sewered population basis, Fargo may discharge 1950 pounds a day of ultimate B.O.D. and Moorhead may discharge 850 pounds a day of ultimate B.O.D.? Is this agreeable or not?

MR. SMITH: From my calculations and the design data for the proposed expansion of the Moorhead plant, this would mean a B.O.D. removal of 95 percent or better from the domestic sewage, and this could not be accomplished without, I believe, going to impoundment of the effluent.

CHAIRMAN STEIN: That is probably so. I don't think there is any doubt about that.

MR. SMITH: I don't know how Mr. Van Heuvelen has figured this for Fargo.

CHAIRMAN STEIN: I think this would possibly, as I understand it from our people, and correct me if I am wrong, require impoundments at Fargo too. Is that correct? If I am wrong, correct me on that so we can join the issues.

Well, let's see, let me try one more thing, if I can get it, because I think this deals with that five parts per million B.O.D. minimum.

As I understand it, the states have proposed a three part per million B.O.D. minimum based on a one-day ten-year flow, is that right?

MR. PETERSON: Not B.O.D., Mr. Stein. You mean--

CHAIRMAN STEIN: D.O. I am sorry, D.O. That is right, I stand corrected. Is that correct? Is this agreeable? This is what the state is proposing?

MR. VAN HEUVELEN: Will you repeat yourself again?

CHAIRMAN STEIN: Well, instead of requiring a five part per million dissolved oxygen general minimum in the Red River as computed in the report, it is understood that the States would rather have this computed on a three part per million minimum D.O. in the Red River based on the low day in the ten-year cycle, single low day in the ten-year cycle. This is my understanding. Is that correct?

MR. VAN HEUVELEN: Actually I think the states, both Minnesota and North Dakota, in the IJC, International Joint Commission, are working for five parts per million for the average--what is it?--average monthly flow, 80 percent of the time for the average monthly flow, but I think as you say, the critical flow, minimum daily flow, wouldn't exceed three parts per million 90 percent of the time. I think this is something that is about like the states may come up with on the IJC. This is something that they are working on at the present time. So I think you are probably right in saying that this is what the states feel they can live with and allow some growth of industry in communities on the Red River.

CHAIRMAN STEIN: Mr. Clare, do you have any view on this of what you would like to see if we can come to an agreement or not?

MR. CLARE: Well, it seems that the five parts per million figure is used more widely than three parts in northern climates, I mean northern parts of the United States.

Personally, I would like to see us use a five part per million limit, but I can't see too much difference, actually, between the five parts per million based on the low flow once in five years versus three parts per million based on a low flow once in ten years. Is that what we are talking about?

CHAIRMAN STEIN: This is what I understand the proposition is. Now, I understand both of these--and again I wish the technical people would correct me if I am wrong--both of these would require something in addition to what we ordinarily term primary and secondary treatment and would require lagooning. Is this correct?

MR. SIDIO: That is correct.

CHAIRMAN STEIN: So it is just a question if you adopt either one. And I understand the reluctance in asking a community, and I think we have to recognize what we are doing here, asking a community which has primary and secondary treatment in addition to that to supply lagooning and hold the waste out to push the bacterial count down and push the B.O.D. down, and so forth, by this lagooning method, because this kind of treatment will be among the highest municipal treatment we have today. I think Mr. Smith's point was correct. I know of no plan that provides secondary treatment of any kind that can provide a consistent 95 percent reduction in B.O.D. I think the figures range between 85, perhaps, and 95 or 92. They are lucky when they get 85. Recognizing this, we are not going to ask any plant here to do the impossible.

So in addition to the primary and secondary treatment, what is proposed is tertiary treatment and this would be in the form of lagoons. You have to recognize, too, that for cities like Moorhead and Fargo the acquisition of lagoons is going to be quite a problem. They are going to need extensive lagooning. However, as I understand it again, if you talk about your three parts on a one-day ten-year low, this will require that too.

Now, are we really speaking about different things in order to protect the river? And this is a very real problem I have. If I am mistaken in the analysis, let me hear it, because I would hate to come up with a difference when we are both saying the same thing in different words.

MR. SMITH: Have we agreed that five parts per million is necessary?

CHAIRMAN STEIN: Not necessarily. Do you want to agree, do the states agree, that you need three parts per million on a one-day-in-ten-year low? Is that a requirement that you would think is necessary?

MR. SMITH: Three milligrams per liter on the minimum daily flow exceeded 90 percent of the time or, in other words--

CHAIRMAN STEIN: Well, that is different. That is different. Because I think you can really live with five parts on that 90 percent of the time if you follow your first provision that I read in and we agreed on on the suspended solids and five-day B.O.D., and so forth. I don't think you are going to have much difficulty in getting five parts for 90 percent of the time. Am I wrong on that?

MR. SMITH: Oh, I think we are.

CHAIRMAN STEIN: Sure you are. So you see, this takes care--

MR. SMITH: No, no, I think we are going to have difficulty.

CHAIRMAN STEIN: Well, our technical people advise us otherwise on this, and maybe there is a difference.

MR. SIDIO: The calculations that exist presently in the Public Health Service report are based on the low monthly flow that will occur once in ten years. In addition to the calculations that we have in the present report, we have made calculations based on a previous request to consider the low daily flow that will occur once in ten years or once in 3,650 days--

CHAIRMAN STEIN: Who made the request?

MR. SIDIO: The state of Minnesota. And it was found that under those requirements there will have to be more treatment provided than is presently recommended in the existing report.

CHAIRMAN STEIN: Is there agreement with that statement or not as the computations go? As I understand it, this is even more lenient than your three parts daily low in ten years. Now, if that is not correct, we are proceeding under a wrong assumption.

MR. SMITH: I think my problem is where the five parts per million fits into this.

CHAIRMAN STEIN: If we leave out the parts per million, and maybe we don't have to mention that at all, and just deal with the pounds of B.O.D., we may get around this. What do you think of that? Because as I understand it, even if you use the three parts, your B.O.D. restrictions would be at least as tight as these. Would they not, Mr. Sidio?

MR. SIDIO: It would require additional treatment to meet that standard.

CHAIRMAN STEIN: Right.

MR. SIDIO: Additional over what we have recommended.

CHAIRMAN STEIN: Right. Now, I have no brief, if you have a conceptual problem with the five parts, because if we are talking in terms that Fargo may discharge 1950 pounds per day of ultimate B.O D. and Moorhead may discharge 850 pounds a day of ultimate B.O.D., then that could be a recommendation. This would be more lenient, do I understand it, than the computation based on the three parts?

MR. SMITH: If I understand this recommendation, this is maintaining five parts per million at all times.

MR. SIDIO: That is based on the low monthly flow that occurs once in ten years, the low average monthly flow.

CHAIRMAN STEIN: It is not maintaining it-- The answer to that is no, isn't it?

MR. SIDIO: That is correct.

CHAIRMAN STEIN: You won't have five at all times.

MR. SCOTT: I am confused.

CHAIRMAN STEIN: All right, let me try this again as I understand it. And I think this is clear.

The point is, the key point is when you are going to figure the five parts per million. He is taking an average of what the low point is once every month. Right? How do you figure the five parts? Go on.

MR. SIDIO: That is based on a 120-month

period. It would be the low month that would occur once in 120 months over any period of 30 days.

CHAIRMAN STEIN: Yes, but this would--you could pick a day from any of the months or would you have to pick them all out of one month?

MR. SIDIO: They would have all to be in one month or 30 consecutive days.

CHAIRMAN STEIN: They would have to be 30 consecutive days over a ten-year period, right?

MR. SIDIO: That is correct.

CHAIRMAN STEIN: Now, the other would be on three parts per million, sir, you would pick the low single day, just one day over a ten-year period. According to Mr. Sidio's calculations, that will impose a more stringent requirement on the cities and the industries in the area by just picking that single day rather than the 30 consecutive days, even though one is a three parts per million where you pick the single day while the 30 days are five. Is that correct? All right.

MR. VAN HEUVELEN: Was there objection to accepting No. 2 here as it is?

CHAIRMAN STEIN: I have none.

Do you have one, Mr. Smith?

MR. SMITH: Apparently you understand it a little differently than I do.

MR. SCOTT: What are you going to do when Fargo and Moorhead triple in size?

CHAIRMAN STEIN: Sir, by that time I hope--and by the way, Fargo and Moorhead will not just be in this position alone. By that time I hope we will have more effective and more efficient waste treatment. If all we can do is what we are doing now and this country begins to triple in size, we are going to be in serious trouble. I think you heard the Governor this morning when he said, if we can put a man on the moon, we certainly can do this, and there are some--

MR. SCOTT: You will not have the same kind of money as the space agency.

CHAIRMAN STEIN: I am not sure, sir, we

don't have the same kind of money now and I am not sure we need the same kind of money either. I don't want to get on a soap box here, but I think history has shown that civilizations have fallen and declined if they haven't preserved their water supply, and much more than when they have not explored space. I think this is a key point. When you get a water crisis, as in the southwest or as they are having in the east now, I don't think there is any expenditure that is too much. It is just a question that this is something very easy for us.

But I think we have to realize that we are not carving out a program here for all time, just for the next decade, perhaps, where we can get a river in reasonable shape so that we can live on it.

MR. CLARE: Also, Mr. Chairman, it seems that when Fargo and Moorhead triple in size, it is very possible that Colonel Harding's water resources development program will be in operation and the ten-year monthly mean low flow under those conditions would not be the same as they are now.

MR. VAN HEUVELEN: Right. That is the thing that I feel, one reason why you want to stay away from this five parts, because these pounds will lead more towards augmentation of flow, I believe.

CHAIRMAN STEIN: I have no objection to leaving out the reference to the five parts.

Mr. Smith has left.

MR. SCOTT: He will be back.

CHAIRMAN STEIN: Here he is.

MR. VAN HEUVELEN: Five parts or three parts. Let's talk in terms of pounds of B.O.D.

CHAIRMAN STEIN: I think you have a point. And this again, Mr. Scott, is a point I think we are rapidly reaching today where we are not going to have very many more unregulated streams in this country. Every stream will be regulated. And we are even going to even out the peaks and the low points in river flow, and we are going to have to do that in order to provide adequate safeguards for our water. I don't think we are at that day yet, but I think as Mr. Van Heuvelen points out, if we come up with these pounds, I think we have a better chance of getting augmented low flows.

Let me again give you another notion of

where we were in another part of the country in the Coosa River between Georgia and Alabama where we have a paper plant. We believe that paper plant has put in reasonable treatment and we are not asking them to do much more, but we are going to the Congress and we are going to ask the Corps of Engineers to supply us some more water.

I have no brief for any particular figure on pounds, whatever seems to be reasonable, but if we come up with a pound figure like that, I don't think I would have any hesitation in going to the Congress and saying, we have gotten pretty reasonably rigid restrictions on the industries in the Red River Basin, if you want any better water or better quality water we have to provide low flow augmentation, but I--and as I pointed out to Mr. Van Heuvelen before, if we try to go to the Congress and do that without coming up with a real firm program as is proposed here for correcting pollution at the source, we are not going to get it.

I think Colonel Harding pointed out the same thing. In the law it provides that augmented low flow is not to be provided as a substitute for adequate treatment at the source.

Is this agreeable to you people without the five parts per million?

MR. VAN HEUVELEN: That is correct.

CHAIRMAN STEIN: Mr. Smith?

MR. SMITH: Actually what we are talking about, getting as Mr. Van Heuvelen did to the pounds, we are talking about requiring the city of Moorhead and the city of Fargo to at this time go to tertiary treatment?

MR. VAN HEUVELEN: Well, 85 percent.

MR. SMITH: 95 percent. And if my calculations are right, this 1950 pounds for Fargo and the 850 pounds for Moorhead are ultimate B.O.D. When we get back to five-day B.O.D., this is ultimate B.O.D.?

CHAIRMAN STEIN: This is correct, isn't it? Yes. I think, then, we have to say that we would be requiring certainly of Moorhead, and I would think also of Fargo, that they provide at least 95 percent B.O.D. removal, at least, at the present for the design loading for Moorhead. That is correct, isn't it?

MR. SMITH: Are we in a position at this time to require this? Is this to maintain what we are attempting to do in this stream? Is this justified?

CHAIRMAN STEIN: You are right here, as I understand it from Fargo, it is only 85 to 90 for Fargo and they may be able to get by. In other words, for Moorhead it would require lagooning.

Again, listen, if I am making a wrong assumption, correct me, because we don't want to proceed on a wrong assumption. This would require lagooning for Moorhead, wouldn't it?

MR. SIDIO: In all probability, yes. But may I explain one thing here on these levels of reduction?

CHAIRMAN STEIN: Yes.

MR. SIDIO: Mr. Smith's figures are at least very close to being accurate. The reason why one city would have to have have a greater reduction than the other is the strength of the sewage coming into the plant. The strength of waste coming into the Fargo plant is somewhere about 150 parts per million or milligrams per liter of B.O.D. The waste coming into the Moorhead plant is in the vicinity of 470 milligrams per liter. Now, based on a common concentration in the discharge, then, of course, Moorhead must provide a greater degree of treatment to accomplish that than the city of Fargo would. In reality, the degree of treatment required of the city of Fargo here would be in the order of 88 percent reduction of B.O.D. Moorhead would require somewhere around 95 or 97 percent.

CHAIRMAN STEIN: Where do we stand on this, gentlemen? As far as I can see, Fargo probably can get by with a real well-operated secondary treatment plant.

Where does Moorhead get that extra strong waste? Do they have an industry coming in?

MR. SMITH: There is a milk plant, for one.

CHAIRMAN STEIN: Well, I think this is, again, obviously you have a more difficult problem on your side of the river because of the wastes you are accepting in your plant. Where do we stand on No. 2? Are we in agreement with these pounds?

MR. SMITH: I guess so.

CHAIRMAN STEIN: All right. Let's move on.

Disinfection at Fargo and Moorhead is required on a year-round basis. I will stop there with requirements. How do you feel about that?

MR. VAN HEUVELEN: I would like to see--really, the thing I was talking a little bit about this morning, asking some questions about coliform populations or densities from sugar beet wastes--I would like to see a little further study on this. I think we had possibly not enough work in this area to fully solve the problem. I think here before we can make any decisions on this we need further study on it.

CHAIRMAN STEIN: What do you think of that? Why don't we do that definitive work on this?

MR. SIDIO: The reason that we did not do this is that the present requirements are based on coliform levels. Now, this doesn't mean that we can't conduct these fecal strep tests and determine the exact source of them. But when we are doing this work, we can only take so many tests in the laboratory at one time, and when we add that many examinations per day, it certainly cuts down on the amount of information that we can collect.

CHAIRMAN STEIN: O.K. Well, I do think Mr. Van Heuvelen has a point there.

Mr. Geldreich, when is the time to do this? What time of the year is the time to take these tests?

MR. CLARE: While Mr. Geldreich is coming up, may I ask do both Fargo and Moorhead presently have chlorinating facilities?

MR. RUBY: The city of Fargo does not have chlorinating facilities.

CHAIRMAN STEIN: What is the best time to take these tests?

MR. GELDREICH: Particularly from the data-- Now, we have actually done some data that does not appear in the report. My group back in Cincinnati, in working with Mr. Sidio and his team, made approximately 700 bacteriological determinations. We found that this material will allow the persistence or the multiplication of fecal coliforms for periods over 72 hours, that in the wintertime when the beet factories are working, this particular waste in the streams receiving this waste does support growth of the organisms. And the thing that I am most concerned with is the Salmonella being grown in this material also. We must reduce the nutrients to a level which will prevent the fecal coliforms from--

CHAIRMAN STEIN: We are talking about chlorination. That won't get the nutrients, will it?

MR. GELDREICH: No.

CHAIRMAN STEIN: O.K. Let's do one at a time. I think you may have a point there.

The question I asked you is when is the best time to do this survey? I think this is a real question of what we have. If you are dealing with pathogenic organisms and fecal strep, this is the key point that we are very much interested in, not just here but everywhere else, is whether those in fact coming out of these plants, go down the stream, and whether they require chlorination. I don't think Mr. Van Heuvelen or anyone else in any health department would say if you have a health hazard you shouldn't chlorinate.

MR. VAN HEUVELEN: Whether you should chlorinate.

CHAIRMAN STEIN: The question here is, we are talking in terms of getting the evidence for an evaluation. Now--

MR. GELDREICH: We have to do it while the industry is operating.

CHAIRMAN STEIN: This campaign?

MR. GELDREICH: Yes, sir.

CHAIRMAN STEIN: Can you be set up to do it this campaign?

MR. GELDREICH: With the help of the TA&I staff, we may be able to assist you in this respect. We have, I guess, what, four months left during the campaign? Let's see, this is September. We would have sufficient time. I am sure we can get some of these determinations made for you and fit it into our schedule.

CHAIRMAN STEIN: All right. Well, I think what we would want is a check on whether the pathogenic organisms are in fact coming out in sufficient numbers and quantities from Fargo and Moorhead to warrant year-round chlorination.

Now, there is no chlorination at all in Fargo. Are you in agreement that chlorination should be provided during the summer season or not?

MR. VAN HEUVELEN: I don't think you can just say it is needed. That is what I think we need further study for, what is the degree of pathogen carryover there.

CHAIRMAN STEIN: Could we resolve this on this question, and this is a real question, because I think if we move ahead with the other parts of the program we will have made sufficient advances, for the question of tracing the pathogens and the viruses and determining the need for chlorination to await a study during this season and under the ice cover, and so forth, and then reconvening of the group possibly just to make a determination on that question? Because I don't think that this will throw the rest of the program off.

MR. VAN HEUVELEN: I think my concern is that if we go to expensive chlorination for Fargo and Moorhead, will we solve the problem. I think we want to be sure we are going to solve the problem.

MR. GELDREICH: Sir, pardon me, you do have Salmonella appearing in September out of the waste discharges. You remember September did, they were finding them. At the time they didn't even set up sampling stations for Salmonella further up the stream, but they were finding them even when the beet plants were not operating, the potato plant apparently was not operating. They are certainly related to the pollution coming from the cities, waste discharges. So all we would be doing is giving you an answer as to degree if we were lucky enough to make this determination.

MR. VAN HEUVELEN: That is the thing I think we want, isn't it?

MR. GELDREICH: They are there. The problem is are the beet plants contributing more or are the wastes of the beet plants allowing us now to have so many nutrients that we are going to get what we call regrowth.

MR. VAN HEUVELEN: I think that is the question.

CHAIRMAN STEIN: To move this along, I think we are going to have both phases here on this whole disinfection by chlorination question, whether we are going to chlorinate municipal wastes, beet plant wastes or both, and if we are going to chlorinate all year round. First, this part of the program, the kind of chlorination facilities, the installation or lack of installation, would not delay the rest of the program.

MR. GELDREICH: That is correct.

CHAIRMAN STEIN: The rest of the facilities. Secondly, I think this possibly is the kind of question we have to, in a sense, try to provide with the kind of answers Mr. Van Heuvelen and, of course, Minnesota want of us.

I would suggest that before we undertake this study, and we will have to start this pretty soon because I guess the campaign has started, that we do set up an acceptable methodology for both Minnesota and North Dakota so we can be pretty sure when we get the answers we are going to have them one way or the other.

Would this be agreeable on that?

MR. GELDREICH: Yes. Mr. Sidio's group did this work and the techniques they used, I think, would be highly desirable to set up procedures.

CHAIRMAN STEIN: We are not arguing the technique. I have worked, as you know, very closely through the years with Harold Clark.

MR. GELDREICH: Yes.

CHAIRMAN STEIN: Who has developed a lot of this, and I am very impressed with his Salmonella technique. But I think the question is, we have to throw a lab in here and get pretty full results.

The reason I suggest this here is that this isn't just an answer we want for this area, but it is going to be an answer which will be useful throughout the country. I think this is a good base, one, because we have the request, and, secondly, because one way or another the Red River has been studied so many times and we can make projections pretty well on this river.

Why don't we try that on this point? O.K.?

MR. GELDREICH: We worked on the beet problem in Utah several years ago on Cash River and we have also been involved in the North Platte and we are becoming involved in the South Platte, so this is a growing concern and we are very much interested in this extra effect.

CHAIRMAN STEIN: All right.

MR. GELDREICH: Thank you.

CHAIRMAN STEIN: Thank you.

Now, the next point--

MR. SMITH: Wait. Before we go on, I would like to go back to No. 2 again. I would like a justification for apportioning the load on the sewered population basis.

CHAIRMAN STEIN: Do you want to talk about that, Mr. Sidio?

MR. SIDIO: A municipality that produces wastes may permit or allow industries to go into that system according to their wishes. Whenever we have 20,000 people putting wastes into the river on one side and 10,000 people putting wastes into the river on the other side, it would appear to us that the equitable means of breaking down a permissible load would be to have the one have one-third and the other have two-thirds. That is the justification of our breaking it down on a population basis.

MR. SMITH: Wouldn't it be just as equitable to do this on flow to the river, the drainage basin, the river flows? If the total flow came from one side of the river, shouldn't this side of the river receive some consideration for this?

MR. SIDIO: I have never, as far as I know, come across any situation where a breakdown has been made in that manner.

CHAIRMAN STEIN: Let me see if I understand you, Mr. Smith. You mean flow of tributaries in the river?

MR. SMITH: This is correct.

CHAIRMAN STEIN: You mean Minnesota should be entitled--this is just--

MR. SMITH: Don't you find this quite frequently? Aren't you finding this very thing in the Great Lakes?

CHAIRMAN STEIN: No. As a matter of fact, we go precisely the other way, and I think this is the point. I hope you know we are following the law on this. I would hate to think of the situation with the upstream state having special interests because they controlled the flow of the river, if that would be the law of the land, what would happen to New Orleans and Louisiana and Mississippi. This is more like they are in the Middle East. I hope we never get into that in the United States.

The point is that I think every state here, at least in the humid east, should recognize that these rivers are flowing by and we should not put the fortuitous position of one state, the upstream state, having a special equity.

You know, Colorado raises this all the time. They say most of the big rivers in the United States are out in Colorado and they should be given special consideration. I don't think anyone else has ever really acquiesced to that theory.

But I think the notion here goes back to what Mr. Sidio said, that what happens is if a municipality takes in an industrial waste, it assumes the legal and technical responsibility for treating that waste. Now, this often becomes a burden. But on the question of allocation, you generally do this on the basis of population served, because generally speaking, if you have an industry there, you have more of a base to put on water charges than the other group is going to have. There is no particular magic.

By the way, I think that industry should go through municipal systems, but I think municipalities accept those industrial discharges in their system with their eyes open and have to assume the responsibility. What you are suggesting, sir, is not consonant with the usual way of doing business in protecting waters in this country.

MR. SMITH: Now, if this industry increasing the waste strength in Moorhead were to have a separate outlet and a separate treatment facility, the city of Moorhead would have a considerably larger allocation of B.O.D. discharge to work out itself.

CHAIRMAN STEIN: No, your B.O.D. allocation to Minnesota would be the same. However, the industry would have to be responsible for a large portion of that and the city would be responsible for a large portion of that. Perhaps, and I have no idea on the strength of the wastes, but if there were no industrial flow into the municipal system of the city of Moorhead, you may have the same kind of strength that Fargo has and be able to get by with reasonable secondary treatment without lagoons. But these lagoons or some kind of treatment is going to have to be somewhere, and perhaps the city wouldn't have to provide it, but the industry would have to provide it in its own waste treatment facilities. But that would still be in Minnesota, and Minnesota's responsibility. It is the choice, the local option that decided that both of these go into one system.

As far as the Federal Government is concerned and its interest in the interstate navigable streams of the country and as far, I am sure, as North Dakota is concerned, it should really make no difference to either one of us how your state makes the arrangement as long as you keep your waste load down. But you have chosen to have an integrated system.

May we try to go on? How about four? It will be necessary for the American Crystal Sugar Company plant at Moorhead to discharge waste in accordance with Chart A-5 of the Technical Appendix. What do you think of that? That deals in pounds per day.

MR. SMITH: I believe Mr. Porterfield indicated this would require better than a two-thirds reduction of the waste to accomplish this. I think it is beyond comprehension at this time.

CHAIRMAN STEIN: What do you think, Mr. Clare?

MR. VAN HEUVELEN: I don't know, I think this is on the Minnesota side and I somewhat hesitate to--

CHAIRMAN STEIN: No, I asked Mr. Clare.

MR. VAN HEUVELEN: Oh, I am sorry.

CHAIRMAN STEIN: I am trying to keep you out of this.

MR. VAN HEUVELEN: I had hoped you would.

MR. CLARE: Well, I think that the American Crystal Sugar Company should explore the possibility, of course, of reducing the strength of their waste adequately to maintain the quality of water in the stream. Personally, I haven't checked the figures that Mr. Porterfield gave. I don't know whether Mr. Sidio has or not. But I think we would like to look into this a little bit more before we can answer that definitely.

CHAIRMAN STEIN: Let me have a proposal on this. Can you arrive at an agreement on this? Mr. Van Heuvelen and I are riding free and clear. Can you arrive at an agreement on this with Minnesota that we can solve or not solve on this? What is your suggestion?

MR. CLARE: My suggestion?

CHAIRMAN STEIN: Yes. What do you suggest, that we stay with this? You have heard Mr. Porterfield, you have heard Mr. Smith, and you have this proposal. What do you suggest?

MR. CLARE: Well, as I say, until I can check these figures more, I don't see how I can do anything but stay with this.

CHAIRMAN STEIN: Is this your recommendation, then?

MR. CLARE: Yes.

CHAIRMAN STEIN: And your view, Mr. Smith, is that this will be impossible to obtain? Is that correct?

MR. SMITH: Yes, this is right.

CHAIRMAN STEIN: All right. Let's leave the summary this way on this issue and have to decide how to do this on 4, that on the proposition the PHS representative made the recommendation that it will be necessary for the American Crystal Sugar plant at Moorhead to discharge wastes in accordance with Chart II-5 of the Technical Appendix, that the conferees from Minnesota stated that this would be impossible to attain, and because this was in Minnesota, the conferees representing North Dakota expressed no opinion on the matter. May we go on to the next one?

What do we mean by the maximum practical reduction of the nitrogen and phosphorus? What do we mean by that? Do you know, Mr. Clare?

Mr. Sidio, what do you mean by the maximum practical reduction of nitrogen and phosphorus? What do the plants do?

MR. SIDIO: This in reality is point at the removal and reduction of second stage biochemical oxygen demand.

CHAIRMAN STEIN: I know what it is driving at. I am asking you, in view of the irrigation return flow and the phosphates and nitrates that get in and the uncontrolled nitrogen in the stream, but what do you want them to do in the plants?

MR. SIDIO: At the present time there is no method for--that is, there is no method for directly removing these nutrients, so this recommendation is made in this manner because of that. In other words, it makes the recommendation that they be reduced as soon as possible.

MR. CLARE: Would these be reduced in

holding ponds in tertiary treatment facilities?

MR. SIDIO: To a great extent, yes.

CHAIRMAN STEIN: Let me ask you, what would be the point in the reduction here with this agricultural area and runoff from the land? Aren't you going to get enough phosphates running in off the land to trigger the growth?

MR. GALLAGHER: My name is Gallagher. I am with the Public Health Service in Cincinnati.

We noticed this great algae problem in the river between Fargo and Grand Forks downstream of Fargo at Moorhead sewage treatment plants at just about a time of travel equal to the time it would take the second stage B.O.D. to exercise itself in the stream. Therefore, we concluded that this was a result of the second stage B.O.D.s discharged at Fargo and Moorhead and the American Crystal Sugar Company at Moorhead and that was the cause of the algae problem and the consequent oxygen reduction caused by the death of the algae after the nutrients had been used up in the stream.

CHAIRMAN STEIN: That wasn't really pointed out in the report, was it?

MR. GALLAGHER: Yes, it is pointed out in the Technical Appendix.

CHAIRMAN STEIN: Well, all right. I think if you are going to base a recommendation, we should have had that. But what do you want the plants to do to reduce the phosphates?

MR. GALLAGHER: We want them to be aware of the problem such that it will not be ignored. There is research going on now.

CHAIRMAN STEIN: But do you think that this needs advice and a conclusion without a specific recommendation to the plants? Talking about a maximum--

MR. VAN HEUVELEN: Just leave it as it is. This is fine.

CHAIRMAN STEIN: You don't mind that recommendation?

MR. VAN HEUVELEN: No.

CHAIRMAN STEIN: All right. Do you? Can we leave it as it is? Do you have an objection to this one as it is?

MR. SMITH: To the nutrients, I don't want to be dragging my feet on every one of these, but I don't know what the maximum practical reduction means, nobody does. This could mean elimination of discharge of wastes to the river entirely.

CHAIRMAN STEIN: Oh, I don't--

MR. SMITH: There is nothing that indicates what this means. Or you could be going to what they are doing in Lake Tahoe now.

CHAIRMAN STEIN: You don't have the same conditions.

MR. SMITH: Well--

CHAIRMAN STEIN: Let me try to put this--

MR. SMITH: Show me some places on the Missouri River where right now you are trying to maintain five parts per million of dissolved oxygen. Are you maintaining five parts per million of dissolved oxygen--

CHAIRMAN STEIN: On the Missouri?

MR. SMITH: Yes, below the large cities.

CHAIRMAN STEIN: Oh, much more. As I understand it, we went into that problem, the dissolved oxygen on the Missouri River is way over five, it runs up to seven and eight. This is no problem. The answer is yes.

MR. SMITH: What would happen here now if the city of Moorhead should incorporate, take on larger area and incorporate the area now in which the sugar beet plant is located?

CHAIRMAN STEIN: Well, they would have to decide whether they are going to--just because you have incorporated does not mean that you necessarily have to run that plant effluent through your municipal system.

MR. SMITH: But you still would allocate the total wastes of 850 pounds of ultimate B.O.D. to every industry within that corporate limits. This shows the ridiculousness of that limitation--

CHAIRMAN STEIN: No, no, no. Again you are dealing with this--you are dealing with things that don't happen.

MR. SMITH: No? This can happen very easily.

CHAIRMAN STEIN: The situation you have in dealing with effluent standards, our restriction deals with situations that you have today. You have that all the time with Minneapolis and St. Paul or we had that in St. Louis when you heard about that ninety-five million dollar bond issue when the city of St. Louis joined the Sewer District. Obviously you amalgamate when this happens. This deals with what is coming out of the present Moorhead treatment plant. Any amalgamation, annexation, taking in of new industries obviously changes the situation. Again this isn't for all time.

But I think we are on this nitrogen or phospherus, what I think they mean here, and let me check this and see if I can put this correctly, in the operation of the waste treatment facilities utilized for municipalities and industries, consideration be given to the maximum reduction of nitrogen and phosphorus in these wastes. I wouldn't think that you would have to keep all wastes out. This is what I think they are trying to say.

If there is no objection, I wonder--I think this is just a generalized statement--if we could possibly go on. Reduction of wastes from the American Crystal Sugar Company at Crookston, Minnesota, would require--now, how do we get to this one without mentioning five parts? Is this a problem at Crookston? Can we talk in terms of pounds or what do you want to talk in terms of?

MR. CLARE: Can we convert this to pounds, this five milligrams per liter, when the discharge is less than 330 cfs?

MR. SIDIO: Can we convert it to pounds?

MR. CLARE: Yes.

MR. SIDIO: Yes, I think we can.

CHAIRMAN STEIN: All right, let's see if we can use the same formulation on this as the other and get rid of the five. O.K.? Let's try to go on.

What do you mean by 7? Is this all right as it stands, is this agreeable?

MR. CLARE: This might resolve the question of what are the state standards for coliform for source of water supply.

CHAIRMAN STEIN: I don't think there is any disagreement on that.

MR. CLARE: Oh, O.K.

CHAIRMAN STEIN: You are dealing with the 5,000 number. I think I understand this. Is this agreeable to Minnesota?

MR. SMITH: Yes, this is all right.

CHAIRMAN STEIN: O.K., let's go on to 8. 7 reads:

"The excessive total and fecal coliform densities in the American Crystal Sugar Company wastes at Crookston should be reduced to ensure that the densities in the Red Lake River at East Grand Forks will not exceed the States' standard for a source of water supply."

O.K., 8 reads:

"All sanitary sewage discharged to the Red River of the North at Grand Forks-East Grand Forks"--let me change the "should" to "shall"--"shall be connected to the municipal collection systems and treated in the municipal waste stabilization ponds, or separate adequate treatment provided in accordance with present plans."

Is this agreeable?

MR. VAN HEUVELEN: From North Dakota, yes. As you heard from Mayor Magnuson's letter, this is under way at the present time.

CHAIRMAN STEIN: Is this agreeable to Minnesota?

MR. SMITH: Yes.

CHAIRMAN STEIN: Fine.

"Wastes from the potato plants presently discharging to the Red River at Grand Forks shall be collected and sent to the municipal system following in-plant treatment."

MR. VAN HEUVELEN: Yes.

CHAIRMAN STEIN: O.K. Well, that does the first, right? Do we need 10 at all? Can we eliminate 10? I guess we can, can't we? Because we have agreed with the recommendation for the potato plant. Right? Let's eliminate 10 to simplify this.

Now, if you do not have that computation now before we send the summary out, this is on the Crookston American Sugar plant.

MR. SIDIO: We can give you some values on that right now, if you like.

CHAIRMAN STEIN: What is the figure?

MR. SIDIO: At the most critical temperature of 18 degrees centigrade, a total of 35,500 pounds of biochemical oxygen demand may be discharged per day.

MR. CLARE: Five-day B.O.D.?

MR. SIDIO: Ultimate B.O.D.

CHAIRMAN STEIN: Thirty-five what?

MR. SIDIO: 35,500.

CHAIRMAN STEIN: Do we have to put the critical temperature in?

MR. SIDIO: Wait a minute, I am sorry, I gave you the wrong figure.

CHAIRMAN STEIN: That is what I am worried about. Maybe we had better not do this under pressure. Go ahead.

MR. SIDIO: I am sure this time.

CHAIRMAN STEIN: O.K.

MR. SIDIO: 22,000.

CHAIRMAN STEIN: 22,000?

MR. SIDIO: And this is ultimate B.O.D.

CHAIRMAN STEIN: Is this comparable, and I am not talking in terms of the figures, comparable to the computation we have for Fargo and Moorhead, the B.O.D. pound computation? You did the computation the same way. I don't need a temperature figure here, do I? I am afraid we are pushing you fellows too hard.

MR. SIDIO: If you want to make it comparable to the Fargo-Moorhead situation--

CHAIRMAN STEIN: Yes.

MR. SIDIO: --we have to take it down to the one-in-ten-year low flow basis--

CHAIRMAN STEIN: Why don't we wait in this instance. This is just a matter of computation. Why don't we send that figure with the computation to the conferees.

MR. SIDIO: All right.

CHAIRMAN STEIN: This is just a mechanical matter. What I would not like to do is push you and get you doing this under stress here and come up with the wrong figure.

Now, Mr. Clare points out these two points that might be considered on 10 that I eliminated, maybe too casually. He says, "If slime growths develop and accelerate the rate of deoxygenation and if the discharge creates a significant benthal demand, reduction of wastes during the fall may be required. No discharge can be permitted under ice cover."

Is that agreeable or not?

MR. VAN HEUVELEN: Well, it is pretty much Minnesota's, is it not?

CHAIRMAN STEIN: Yes. Is that agreeable or would you rather not have that? Mr. Smith, what do you think?

MR. SMITH: It is general enough there, I suppose.

CHAIRMAN STEIN: All right. Now I think we are about set on this. How long--and let me ask Mr. Clare for a proposal--how long do you think this should take? What is the proposal for a time schedule?

MR. CLARE: Well, North Dakota says that their new law requires that this be accomplished in less than two years, if I understand their presentation correctly. So I would suggest that a limit of two years be set for accomplishment of the recommendations.

CHAIRMAN STEIN: Is this agreeable?

MR. VAN HEUVELEN: Our law doesn't exactly say that. It says cities who do not now treat sewage must do that, and I think of the two that we have in the Basin that are small, they surely will meet the waste treatment needs.

Right now, I don't see any big problem of meeting this in two years on the North Dakota side.

CHAIRMAN STEIN: Do you have any objection to that two-year period?

MR. SMITH: I think we can do it as far as the municipalities are concerned. I can't say the same thing for the industrial waste problem.

CHAIRMAN STEIN: Do you have a counter-proposal or how do you want to handle that?

MR. SMITH: I would think the East Grand Forks plant has certain changes now being proposed. I would suggest that they be accomplished within two years as well as at Moorhead, and that a five-year period be given the industries to meet these other requirements.

CHAIRMAN STEIN: Go ahead, Mr. Van Heuvelen.

MR. VAN HEUVELEN: I was going to say on this question of Salmonella and also of coliform on the survey, I think that could be furnished to the conferees and a decision made without calling another conference on that. In other words, I would certainly feel North Dakota would be willing to accept a review of the findings of the source of the coliforms. I would think in that case, though, I know one case there was a statement made about the little town of Fairmount, where I felt this wasn't quite right because they sampled north of it but did not sample to the south of that, and I think that should be reviewed too.

CHAIRMAN STEIN: Right. I think this may be a point, what we may have with the other, once this is completed. We may have just a meeting rather than another conference, because I do think that the question here is pretty straightforward, either you have a health hazard or you don't, and if you have a health hazard you are certainly going to take care of it.

MR. VAN HEUVELEN: Right.

CHAIRMAN STEIN: O.K. But let's get back to this other proposition. What do you think about five years, Mr. Clare?

MR. CLARE: Well, that seems a little long. Do you think, Lyle, that it is-- How long do you think it is going to take to find out what needs to be done in the way of correction? Don't we know that pretty well now?

MR. SMITH: We know it needs to be done, we know that they will have to reduce this waste by about 70 percent. I don't think we know how this can be done, how it can be done economically. There is research being carried out right now on this basis and this undoubtedly will take several years before any conclusions are reached.

CHAIRMAN STEIN: I think you fellows are pretty far apart, so let's see if I can wind this up.

In the question of the time table, I think your amendment is well taken, if no one else objects to that, on this survey of the Salmonella material.

But on the time table, the PHS conferee suggests that it can be done in two years, all the work to accomplish this can be done in two years. The conferee from North Dakota indicates that the work on his side of the river can be done within that time. The conferee from Minnesota indicates that their municipal treatment work can be done in two years, but that the industrial work, the industries should be given five years to accomplish this.

Is that a fair statement of the positions? I think, does anyone have anything else they want to bring up in this?

MR. SMITH: Might I ask how many sugar beet plants of this size are providing biological treatment of their wastes?

CHAIRMAN STEIN: Would you mind if I called on Mr. Black for that?

MR. SMITH: No.

CHAIRMAN STEIN: Mr. Black, would you indicate?

MR. BLACK: My name is Hayse Black, Industrial Waste Consultant for the Public Health Service, stationed in Cincinnati.

The question again, please?

CHAIRMAN STEIN: Mr. Smith.

MR. SMITH: I would like to know, Mr. Black, how many or if there are any plants producing sugar by the processing of beets of roughly the same size of the plants we are referring to here that are providing secondary treatment to accomplish, say, a 70 percent five-day B.O.D. removal.

MR. BLACK: It is difficult to answer this without a brief preface. May I make a statement, Mr. Chairman?

CHAIRMAN STEIN: You answer it any way you wish, Mr. Black.

MR. BLACK: We are dealing here with a seasonal operation, which admittedly complicates treatment. Most of the beet sugar refineries in the United States provide storage with controlled release, and some of these plants have been able to reduce their residual wastes, to as low as two pounds per ton of beets sliced. This has been done by closing up and re-using the water, and it has resulted in some cases in some odors, and that is about the only objection, the odors in the area of the ponds that are used for holding these wastes.

Now, it is a matter of arithmetic to convert this two pounds to our present situation. But we do get a reduction of B.O.D. in these ponds, we get reduction of the bacteria in these ponds.

Now, to be more specific in answering Mr. Smith's question, biological treatment hasn't been too successful. There are some, at least one in Utah, another in Idaho, that are using trickling filters, one reportedly with some success, and the other one, because of improper design, really, hasn't been too successful.

In England, considerable work has been done and also in Sweden with biological treatment of beet sugar wastes. But our problem at this latitude with biological filters is the ice that forms that cuts back on the efficiency. So I think what we are really talking about here is holding, reuse of the water, and I believe that is exactly what Moorhead has been doing now ever since they started their plant, so it would be a tightening up of this operation that we are really considering.

CHAIRMAN STEIN: Yes. Mr. Smith, does that answer your question, first?

MR. BLACK: It is a round-about answer, Mr. Smith, but there is no direct answer.

CHAIRMAN STEIN: I am not sure we are considering biological treatment of wastes, that is what I am getting at. We are dealing with a reduction, as I understand it, in pounds of B.O.D. to be discharged by a plant. Now, let me say in my experience on this, many plants are facing the same situation, plants on the Bear River, which by the way runs north too, but it turns around and runs south after a while, plants on the South Platte are right now in negotiation, facing the same problem. The question we have here is the question of reduction in terms of B.O.D. to a level of a permissible discharge and a regulated discharge to put the wastes out at a certain time of the year so it doesn't all go out at once and when water conditions are not critical. I don't know if this is biological treatment, but I do suspect that the sugar beet industry is facing this problem in many parts of the country.

By the way, I am not being impolite by turning away from you, but I am directing my talk to the reporter here. She has difficulty with me when I turn around. So pardon my back.

As I see that, this is a problem increasingly going to be faced by the American sugar beet industry.

Mr. Smith, let me say this. I think that we are witnessing a pretty generalized expansion in the industry, as you stated here. I hope that this expansion will continue. But we have always had a problem with this industry through the years, and it wasn't until our friend Mr. Castro--I don't smoke cigars any more either--took control in Cuba that the sugar beet industry really began to blossom forward financially. The point is, if we don't do it now in the sugar beet industry, and this is a long, long history of getting the wastes cleaned up, I don't know when the times are ever going to be more right, because for years in dealing with the sugar beet industry we heard about the international sugar market and the precarious financial position of the industry. So I do think that we have to recognize this and I think the sugar beet industry is one of the best we have. And as you can see by the attitude of the representative here of the exchange of information, we have had that with all elements of the sugar beet industry.

But I do think, gentlemen, that the time is now for the sugar beet industry to face up to its waste problem.

MR. CLARE: May I ask Mr. Black a question?

CHAIRMAN STEIN: Yes.

MR. CLARE: Mr. Black, would it be necessary to clarify the record on your units? You referred to two pounds per ton of beets sliced. Did you indicate what this is, two pounds of what?

MR. BLACK: Two pounds of B.O.D. lost. Well, that is five-day B.O.D.

MR. CLARE: Yes.

MR. BLACK: And that is, admittedly, a low figure.

MR. CLARE: Yes.

MR. BLACK: It would probably be between two and five, depending on the wishes of the conferees.

MR. CLARE: Thank you.

CHAIRMAN STEIN: Are there any further questions or comments?

Thank you very much, Mr. Black.

Are there any other comments or questions? If not, I think we have gotten along with a very, very difficult problem. I think the Red River is one of the real difficult problems in quality control and it is not going to get any easier. I do think we are on the verge, Mr. Van Heuvelen, of a regulated stream and augmented stream flows, because I see that with you, I don't know that you can demand much more on this stream without providing some kind of relief and extra water during periods of low flow.

But I do think, I do think it behooves the states, the industries and the municipalities to try to get together on a program such as we are developing here and develop, to try to get together on a program of this so we can be able in good faith and come forth proudly and say that you people have done all that we can reasonably require you to do to correct pollution at the source. Because I think that is the essence--we say in the trade the sine qua non--of proceeding to the next step of trying to get some extra water, and I think unless you come in with that kind of a record, we are going to find it very, very difficult. You are in competition with people all over the country for water. If the water--and you are in double competition because it very well may be likely that any extra water you get here may have to come from outside your basin, and this is not easy at the best in the American political system. This is one of the most difficult things to do, is to take water out of one basin and bring it to another for use. In other words, what I am trying to say to the people in this valley, unless your own houses are on it, your chances aren't very, very good. And I think this is a golden opportunity and a chance to put your house in order.

I think we have had a very good conference with an exchange of views. Again we do business in the open. Sometimes it gets a little abrasive because we did not retire into an executive session. Everything was done in a fishbowl, and you saw how it operated, but I think this is the American system in operation. As you can see, your state agencies, your Federal agencies, your municipal representatives and your industries all have their points of view, but I do think that we are on our way to arriving at an accommodation.

If there is nothing more, I would like to thank you all for staying with us and for the conferees who were willing to participate in this give and take. Thank you very much and we stand adjourned.

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APPENDIX I

SUMMARY OF SURVEY DATA

Table 1-A

Red River of the North

September 1964

Summary of Field Data

Station		Flow cfs	Temperature °C	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria		Suspended Solids		Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
							Total MPN/100 ml	Fecal MPN/100 ml	Total mg/1	Volatile mg/1				
BD-1	Avg.	5	18.6	8.6	9.1	3.7	2,800	540	48.8	8.8	150	600	31	759
	Max.	9	25.5	10.2	11.4	5.6	160,000	3,300	85.5	12.0	169	700	36	1175
	Min.	1	14.0	8.0	6.5	0.8	1,100	110	33.0	6.0	137	540	23	554
OT-2	Avg.	69	18.4	8.5	9.5	2.7	1,200	177	43.9	9.7	205	238	4	39
	Max.	80	25.0	10.5	10.3	3.8	17,000	2,300	60.3	12.5	213	270	5	62
	Min.	65	15.0	8.1	7.8	0.7	490	70	31.0	7.5	184	210	3	31
OT-3	Avg.	77	18.6	8.6	8.6	2.7	4,820	610	77.0	12.1	205	233	4	38
	Max.	105	23.0	9.2	10.2	4.3	54,000	7,900	100.6	14.5	222	270	4	48
	Min.	61	15.0	8.3	7.4	0.7	490	70	61.5	9.3	182	210	3	32
RR-4	Avg.	85	18.6	8.6	9.7	3.1	4,170	300	61.6	12.7	206	240	5	56
	Max.	110	22.5	9.2	11.5	3.8	11,000	1,300	110.0	18.0	214	420	6	77
	Min.	70	16.0	8.3	9.4	0.7	1,200	80	40.0	9.5	187	210	4	48
RR-5	Avg.	83	18.3	8.5	9.1	3.4	3,920	400	83.5	13.4	214	249	5	63
	Max.	120	22.5	10.4	10.7	4.4	13,000	1,400	119.0	19.0	218	280	6	75
	Min.	70	15.0	8.4	8.0	0.9	1,300	130	54.0	9.0	205	220	4	53
RR-6	Avg.	73	18.7	8.5	7.5	2.5	1,160	43	64.6	9.2	208	264	5	70
	Max.	85	21.0	9.1	9.0	3.2	4,900	> 90	90.0	21.0	218	330	6	89
	Min.	70	16.5	8.1	7.1	0.6	490	< 20	51.0	4.0	202	220	4	59
RR-7	Avg.	71	18.6	8.3	7.6	2.7	4,700	131	72.9	11.2	210	263	5	74
	Max.	80	21.0	8.7	7.9	3.1	13,000	490	84.0	15.5	225	290	7	98
	Min.	65	15.5	8.1	7.1	0.6	1,800	20	58.5	5.5	199	230	4	63
WD-8	Avg.	1	17.9	8.6	7.4	5.3	2,960	295	67.1	13.8	325	394	31	217
	Max.	< 2	24.0	9.0	9.0	7.4	35,000	4,900	81.0	16.5	336	420	33	222
	Min.	< 1	13.0	8.3	5.8	1.6	460	20	58.0	12.0	317	366	29	207
RR-9	Avg.	70	19.1	8.4	8.9	3.4	1,730	236	41.9	7.5	200	266	6	69
	Max.	72	22.0	10.0	10.5	4.8	4,600	1,400	53.0	11.0	231	320	10	98
	Min.	66	15.0	8.0	7.8	0.6	790	20	23.5	3.5	206	226	5	41
RR-10	Avg.	75	19.5	8.1	4.4	9.8	865,000	233,000	61.4	14.1	203	268	17	98
	Max.	80	23.5	8.6	6.4	12.6	2,800,000	790,000	72.0	16.5	209	310	21	116
	Min.	70	15.5	7.9	2.0	2.8	79,000	33,000	44.0	12.0	197	220	11	85
RR-11	Avg.	76	19.3	8.3	5.9	8.5	250,000	64,500	111.8	22.1	209	306	20	112
	Max.	85	24.5	9.7	14.5	10.0	920,000	540,000	127.0	24.0	248	340	43	157
	Min.	70	16.0	7.8	1.5	1.7	500	< 200	96.5	20.0	202	270	11	100

Table 1-A (Cont.)
Red River of the North
September 1964
Summary of Field Data

Station		Flow cfs	Temperature °C	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR-12	Avg.	81	18.4	8.2	8.1	7.6	47,600	2,850	141.1	20.4	235	315	46	151
	Max.	95	23.0	10.2	11.6	8.1	220,000	11,000	201.0	32.5	240	350	54	164
	Min.	70	15.0	7.7	6.1	1.5	33,000	1,100	116.5	20.0	230	280	39	135
SH-13	Avg.	67	17.6	8.3	8.8	4.8	68,000	1,530	134.6	23.4	258	309	73	189
	Max.	110	22.0	8.8	10.6	5.6	280,000	7,900	194.0	28.0	271	340	91	280
	Min.	55	14.0	8.1	7.3	1.1	22,000	700	82.0	17.0	237	270	59	160
RR-14	Avg.	182	17.7	8.5	8.3	6.4	16,800	1,510	142.4	22.4	243	309	40	150
	Max.	225	22.0	10.1	10.3	7.2	54,000	3,300	193.0	25.0	251	340	46	161
	Min.	160	15.0	8.1	6.5	1.1	3,300	490	111.0	19.0	235	270	35	137
RR-15	Avg.	[illegible]	18.1	8.4	10.0	5.9	4,590	500	152.2	26.0	244	307	40	149
	Max.	[illegible]	23.5	8.7	13.1	6.9	11,000	1,300	202.0	37.0	252	340	46	163
	Min.	160	15.0	8.2	6.9	1.6	2,300	130	81.0	17.0	233	270	34	135
RR-16	Avg.	187	18.3	8.7	12.4	7.0	990	126	96.0	22.3	237	303	39	146
	Max.	225	21.5	9.7	19.4	9.0	3,300	790	118.0	28.0	252	340	48	166
	Min.	160	15.0	8.3	5.8	0.9	230	20	75.0	17.5	205	270	20	116
WM-17	Avg.	29	17.5	8.5	8.4	1.8	12,450	4,550	30.5	5.9	250	286	4	63
	Max.	33	20.0	10.2	9.3	2.5	35,000	13,000	54.0	10.0	262	320	5	70
	Min.	25	16.0	8.1	7.1	0.7	2,200	230	18.3	3.3	234	230	4	59
RR-18	Avg.	218	18.1	8.7	14.0	7.0	1,970	117	[illegible]	21.9	239	301	35	136
	Max.	255	22.0	9.2	18.0	8.9	13,000	330	111.0	27.0	246	330	41	153
	Min.	192	15.0	8.3	10.1	2.5	330	20	53.0	14.0	231	270	29	118
RR-19	Avg.	225	17.5	8.8	11.7	8.3	2,200	26	82.9	22.8	223	284	35	138
	Max.	260	20.5	9.0	15.1	11.5	7,900	110	102.0	26.0	230	310	38	153
	Min.	200	15.0	8.5	8.1	6.3	330	< 20	74.0	18.0	214	260	30	122
RR-20	Avg.	232	17.6	8.8	9.9	6.7	1,260	23	76.2	21.8	218	291	38	141
	Max.	260	20.5	9.1	11.6	10.1	4,900	50	106.0	27.2	231	330	43	156
	Min.	200	14.5	8.5	7.7	5.6	490	< 20	63.5	18.8	205	250	35	126
RR-21	Avg.	297	17.4	8.7	9.0	5.8	13,300	82	114.9	22.5	227	280	32	119
	Max.	500	21.0	8.9	10.2	6.9	160,000	1,720	231.0	37.5	303	350	44	142
	Min.	230	14.5	8.5	8.1	4.4	1,300	< 20	71.5	11.5	200	230	14	53
RR-22	Avg.	325	17.8	8.7	8.1	4.5	710	43	67.7	14.7	195	258	31	112
	Max.	490	20.5	9.0	10.2	7.1	17,200	1,300	96.8	19.6	234	320	43	143
	Min.	220	14.0	8.6	6.3	3.3	140	< 20	38.0	10.5	124	180	17	68

Table 1-A (Cont.)

Red River of the North

September 1964

Summary of Field Data

Station		Flow cfs	Temperature °C.	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR-23	Avg.	333	18.7	8.3	6.9	3.2	1,160	55	72.2	11.9	183	251	27	101
	Max.	500	21.0	9.2	8.0	4.0	4,900	330	88.0	14.0	232	280	39	126
	Min.	220	16.0	7.8	6.3	0.9	200	< 20	60.5	10.0	105	170	11	61
RL-24	Avg.	247	18.2	8.5	9.2	1.7	918	35	34.1	8.3	177	243	4	69
	Max.	300	22.0	8.8	9.8	2.5	4,900	80	66.8	15.6	192	310	5	109
	Min.	190	15.0	8.3	8.1	1.0	220	< 20	17.2	3.6	165	210	3	48
RL-25	Avg.	254	18.2	8.3	8.8	2.1	27,300	248	55.8	9.8	171	230	4	81
	Max.	340	21.0	8.5	9.8	2.8	[illegible]	22,100	76.0	14.4	189	270	7	116
	Min.	200	16.0	8.0	7.8	1.6	4,900	20	43.2	4.0	164	190	2	51
RL-26	Avg.	277	18.4	8.3	8.5	2.6	6,570	28	48.8	11.0	172	248	6	91
	Max.	380	21.5	8.6	10.9	4.4	23,000	90	56.8	14.0	185	260	9	122
	Min.	200	16.0	8.1	7.1	1.7	2,210	< 20	43.4	6.4	145	210	4	66
RR-27	Avg.	607	17.7	8.3	7.4	2.3	9,050	222	63.4	12.0	179	245	17	104
	Max.	383	19.5	8.6	8.1	2.6	79,000	1,410	73.0	14.5	210	200	26	177
	Min.	419	15.0	7.7	6.9	1.9	2,780	< 20	50.4	8.0	137	290	8	58
RR-28	Avg.	625	18.0	8.3	8.2	3.6	56,500	1,160	90.1	14.4	134	266	30	107
	Max.	880	21.0	8.5	8.6	6.9	221,000	17,200	140.0	19.2	213	310	39	127
	Min.	430	16.0	8.0	7.7	2.4	17,200	200	58.5	10.4	142	210	20	75
RR-29	Avg.	648	18.3	8.4	8.2	3.2	35,600	890	192.3	23.8	188	271	32	111
	Max.	890	21.3	8.7	9.3	3.1	172,000	4,600	371.0	35.5	218	320	40	127
	Min.	450	16.0	8.0	7.3	2.0	4,600	220	81.2	13.5	142	220	22	75
RR-30	Avg.	662	17.6	8.4	8.5	3.0	23,000	312	98.0	15.8	190	279	31	113
	Max.	900	21.0	8.6	9.2	3.6	79,000	1,300	177.0	20.0	215	310	37	132
	Min.	470	15.0	8.2	7.7	2.4	7,900	130	75.0	10.5	140	220	23	77
RR-31	Avg.	698	18.0	8.3	8.5	2.5	22,800	332	72.5	14.6	193	283	60	127
	Max.	910	21.0	8.6	9.5	3.1	160,000	1,300	92.4	20.5	214	340	73	143
	Min.	500	16.5	8.0	8.1	1.7	1,720	80	63.0	8.0	147	240	50	97
RR-32	Avg.	711	17.9	8.4	9.0	2.6	22,800	51	101.5	15.6	201	297	56	132
	Max.	910	21.5	8.6	10.1	3.3	54,200	180	142.0	18.5	215	330	74	142
	Min.	530	16.0	8.1	8.2	2.2	4,900	< 20	86.0	12.0	173	250	44	110
FR-33	Avg.	6	16.6	8.6	10.6	11.2	4,350	183	82.5	25.4	182	642	1500	565
	Max.	8	24.5	8.7	12.3	17.1	49,000	790	126.0	32.0	213	750	1720	1030
	Min.	4	12.0	8.5	8.7	7.3	1,300	20	58.8	20.5	163	530	1355	462

Table 1-A (Cont.)

Red River of the North

September 1964

Summary of Field Data

Station		Flow cfs	Temperature °C	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR-34	Avg.	739	17.4	8.4	8.8	2.2	24,400	39	116.0	16.0	205	305	88	140
	Max.	930	20.5	8.7	9.6	2.7	160,000	130	160.0	20.0	215	330	182	152
	Min.	590	16.0	8.0	8.1	1.6	7,000	< 20	101.0	13.0	192	270	42	132
PR-35	Avg.	8	16.9	8.8	21.0	20.2	3,870	221	56.4	29.1	193	873	3,996	844
	Max.	11	20.0	9.0	31.4	> 32.7	24,000	700	98.5	34.5	250	1,000	4,850	990
	Min.	5	12.5	8.5	11.7	8.1	1,720	50	34.0	24.0	155	750	1,805	791
RR-36	Avg.	766	16.9	8.3	8.9	1.9	15,900	298	103.7	17.3	204	312	117	146
	Max.	956	20.0	8.5	9.4	2.2	34,800	1,[illegible]10	144.0	24.0	215	350	150	161
	Min.	638	15.5	8.0	8.5	0.7	7,000	50	71.0	10.5	191	270	76	137
RR-37	Avg.	800	17.2	8.4	9.4	1.9	2,900	35	98.3	16.3	202	315	106	144
	Max.	930	20.0	8.7	10.2	2.9	14,100	110	161.0	24.5	220	350	140	153
	Min.	720	15.5	8.2	9.2	0.8	490	< 20	45.0	8.0	180	270	71	132
PE-38	Avg.	113	16.2	8.3	8.9	1.6	9,850	400	71.2	14.0	194	281	13	164
	Max.	160	19.0	8.5	9.8	2.4	92,000	7,900	122.0	19.6	236	320	19	175
	Min.	80	14.0	8.1	8.0	1.2	2,210	130	35.5	10.0	156	220	9	116
RR-39	Avg.	868	16.5	8.5	9.0	1.7	914	25	102.0	16.5	197	310	100	141
	Max.	1,040	19.5	8.6	9.5	2.8	4,600	130	178.0	24.0	208	340	140	153
	Min.	720	14.5	8.3	8.5	1.3	230	< 20	46.4	9.6	183	270	63	129
OT-40	Avg.		18.1	8.2	8.0	1.7	210	24	7.4	3.1	171	203	3	2
	Max.		20.0	8.5	8.5	2.0	490	70	9.9	4.0	173	220	4	3
	Min.		17.0	7.9	7.6	0.7	90	< 20	5.7	1.3	168	190	2	0
OT-41	Avg.		18.8	8.2	8.1	3.0	16,200	4,760	15.4	5.6	197	233	5	11
	Max.		23.0	8.6	9.9	5.3	160,000	54,000	22.6	8.3	215	270	8	18
	Min.		16.0	8.0	7.4	1.1	3,300	490	11.0	3.9	178	200	4	5

Table 1-B
Red River of the North
September 1964
Summary of Field Data

Station		Flow cfs	Temperature °C.	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR-9	Avg.	234	7.7	7.9	10.8	2.0	314	49	40	9	204	235	5	24
	Max.	280	10.0	8.3	11.4	2.6	2,300	130	48	26	221	250	9	36
	Min.	200	5.0	7.6	10.2	1.6	140	< 20	32	3	174	220	4	9
RR-10	Avg.	230	8.9	7.8	5.8	15.4	432,000	155,000	53	15	216	246	9	34
	Max.	275	12.0	8.1	7.1	20.0	1,100,000	490,000	73	20	231	280	13	53
	Min.	200	7.5	7.6	4.7	9.8	230,000	70,000	32	11	206	220	8	12
RR-11	Avg.	229	8.3	7.8	3.5	10.7	249,000	35,600	44	14	220	246	9	33
	Max.	270	11.0	8.1	5.3	15.7	790,000	230,000	50	18	234	260	20	50
	Min.	200	6.0	7.6	2.0	7.5	33,000	23,000	40	11	201	230	7	10
RR-12	Avg.	292	8.1	7.9	4.8	6.3	68,000	16,900	26	10	235	271	15	94
	Max.	320	10.0	8.1	6.1	7.3	240,000	49,000	38	19	280	290	22	237
	Min.	270	6.0	7.7	3.6	4.6	33,000	7,000	12	3	220	260	3	40
SH-13	Avg.	64	6.8	8.1	11.5	3.4	1,410	203	29	9	275	325	43	139
	Max.	95	10.5	8.3	12.5	4.0	4,900	1,300	42	16	291	350	56	217
	Min.	50	3.5	7.8	10.4	2.9	330	20	18	4	232	210	16	171
RR-14	Avg.	318	7.8	7.9	6.5	4.2	27,100	8,160	20	10	251	287	20	77
	Max.	340	9.0	8.2	7.4	5.3	49,000	17,000	26	21	289	310	31	101
	Min.	280	5.0	7.7	5.7	3.6	7,900	3,300	15	4	234	270	16	42
RR-15	Avg.	319	7.8	7.9	8.0	4.4	20,300	5,310	20	8	249	285	17	78
	Max.	350	10.0	8.2	9.4	5.5	490,000	23,000	25	15	281	310	19	94
	Min.	280	5.0	7.6	7.1	3.3	7,900	1,300	16	2	234	260	15	55
RR-16	Avg.	316	7.5	8.0	10.0	4.8	6,630	1,610	34	10	250	284	18	78
	Max.	350	10.5	8.3	12.0	6.5	24,000	4,900	59	14	274	300	20	98
	Min.	275	5.0	7.7	8.8	3.4	1,700	500	24	4	233	270	16	45
WH-17	Avg.	67	7.0	8.1	11.0	1.1	3,670	1,820	8	4	270	298	3	33
	Max.	100	9.5	8.3	12.4	1.3	17,000	4,600	13	6	281	350	4	42
	Min.	50	5.0	7.0	9.5	0.8	700	170	2	3	253	280	2	10
RR-18	Avg.	380	7.2	8.1	11.1	4.4	4,180	722	59	13	260	289	15	68
	Max.	440	10.0	8.4	12.7	5.7	17,000	3,300	98	19	277	320	16	84
	Min.	347	5.0	7.8	9.5	3.6	790	170	35	5	253	270	13	35
RR-19	Avg.	378	7.1	8.1	12.2	4.4	2,650	780	46	13	255	285	15	68
	Max.	430	9.5	8.5	13.7	5.4	7,900	3,300	75	18	261	290	16	84
	Min.	350	5.0	7.9	10.6	3.5	700	270	32	8	248	280	7	37

Table 1-B (Cont.)

Red River of the North

September 1964

Summary of Field Data

Station		Flow cfs	Temperature °C	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR-20	Avg.	384	6.8	8.2	12.9	4.6	1,130	250	43	13	255	286	16	73
	Max.	440	9.5	8.5	14.9	5.3	14,000	790	62	16	263	300	14	93
	Min.	355	5.0	7.9	11.0	3.8	330	20	34	4	246	270	17	43
RR-21	Avg.	401	6.8	8.3	13.6	4.7	1,410	247	44	13	257	293	15	73
	Max.	440	10.0	8.7	16.0	5.9	13,000	1,700	62	19	269	300	17	93
	Min.	370	5.0	8.0	12.1	3.8	330	20	30	3	247	280	14	44
RR-22	Avg.	401	7.0	8.4	14.8	4.8	125	20	27	12	257	295	15	74
	Max.	440	9.0	8.8	16.7	6.0	790	20	33	14	270	310	17	92
	Min.	370	5.5	8.0	12.9	3.9	20	< 20	20	7	246	290	14	52
RR-23	Avg.	401	6.7	8.7	16.2	5.4	48	< 20	41	14	256	293	15	73
	Max.	440	9.0	9.0	18.6	6.5	330	40	54	20	277	300	17	95
	Min.	370	5.0	8.5	13.9	4.1	< 20	< 20	31	6	203	280	9	52
RL-24	Avg.	1063	6.1	8.0	12.0	2.1	3,040	670	28	8	191	239	2	70
	Max.	1210	10.0	8.3	12.6	2.9	11,000	2,300	40	11	265	280	16	90
	Min.	830	4.0	7.7	11.3	1.3	490	130	16	3	170	220	1	39
RL-25	Avg.	1086	6.3	8.0	10.7	3.4	29,500	6,940	29	10	176	245	2	80
	Max.	1,250	9.0	8.3	11.7	4.3	49,000	33,000	34	12	184	260	2	107
	Min.	880	4.0	7.7	10.0	2.4	7,000	1,300	20	6	171	220	1	54
RL-26	Avg.	1115	6.3	8.3	10.6	2.6	9,800	1,120	27	10	185	257	4	87
	Max.	1250	8.5	8.9	11.2	3.2	> 160,000	7,900	37	18			18	157
	Min.	910	4.5	8.1	9.8	1.9	790	170	17	4			1	52
RR-27	Avg.	1512	6.1	8.6	12.2	3.4	9,160	1,440	34	10	199	271	6	84
	Max.	1610	8.0	9.3	12.9	4.7	33,000	5,000	45	18	209	330	12	133
	Min.	1380	4.5	8.3	11.2	2.7	2,780	490	23	4	193	240	3	54
RR-28	Avg.	1515	6.4	8.5	11.6	6.0	39,800	2,970	59	14	203	271	8	88
	Max.	1610	8.0	8.7	12.6	10.3	160,000	23,000	139	22	211	300	15	138
	Min.	1320	4.0	8.3	11.0	3.8	7,900	790	34	8	195	260	[illegible]	57
RR-29	Avg.	1525	6.6	8.5	11.1	5.2	27,800	1,030	45	12	204	278	8	85
	Max.	1620	9.0	8.7	12.3	8.2	240,000	5,000	82	15	215	330	12	146
	Min.	1340	5.0	8.2	10.1	3.8	4,900	211	26	7	195	260	4	30
RR-30	Avg.	1525	6.4	8.5	11.2	4.8	21,900	606	42	12	201	271	7	86
	Max.	1680	8.0	8.6	11.9	7.6	54,800	4,900	55	19	207	310	11	138
	Min.	1350	5.0	8.2	10.5	3.6	7,900	200	29	7	194	260	3	55

Table 1-B (Cont.)
Red River of the North
November, 1964
Summary of Field Data

Station		Flow cfs	Temperature °C.	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR-31	Avg.	1545	6.0	8.4	11.2	4.6	19,000	1,100	32	11	210	285	13	94
	Max.	1640	7.0	8.7	12.7	7.4	49,000	7,900	44	16	318	380	18	140
	Min.	1380	5.0	8.2	10.3	3.6	4,900	< 200	22	6	195	260	7	57
RR-32	Avg.	1561	6.4	8.5	11.4	4.9	11,200	195	45	12	204	278	14	95
	Max.	1660	8.0	8.8	12.1	8.6	34,800	330	56	18	210	320	19	134
	Min.	1360	5.0	8.2	10.1	3.8	1,720	110	37	6	194	260	7	63
FR-33	Avg.	11	5.4	8.4	12.4	9.1	1,730	87	79	22	214	784	1443	533
	Max.	56	10.0	8.7	14.5	12.4	13,000	330	88	28	233	970	2070	725
	Min.	0	3.0	8.2	10.3	6.0	790	20	53	14	199	650	990	434
RR-34	Avg.	1591	5.7	8.5	11.6	4.4	13,100	189	53	11	281	285	49	112
	Max.	1700	7.0	8.7	12.2	5.4	49,000	700	65	16	337	330	61	158
	Min.	1300	4.5	8.2	10.9	3.4	3,300	< 20	46	3	201	220	13	67
FR-35	Avg.	7	4.4	8.5	15.1	6.0	501	70	23	12	274	1007	3314	802
	Max.	8	10.5	8.9	19.6	8.9	1,300	300	36	16	345	1350	5795	977
	Min.	7	0	8.2	9.3	4.0	230	< 20	15	6	207	510	1505	340
RR-36	Avg.	1611	5.8	8.5	11.8	4.2	6,170	476	55	11	216	307	67	121
	Max.	1730	7.5	8.8	12.8	5.3	24,000	2,300	62	16	341	380	39	173
	Min.	1180	4.5	8.3	11.[illegible]	3.4	< 2,000	< 20	44	5	198	270	50	74
RR-37	Avg.	1562	6.0	8.5	11.7	3.7	3,500	56	46	10	214	299	58	118
	Max.	1680	7.5	8.8	12.3	4.5	17,200	830	64	19	277	330	82	153
	Min.	1160	5.0	8.4	11.1	2.9	1,300	< 20	34	6	199	270	23	74
FR-38	Avg.	50	5.0	8.5	12.1	1.8	561	40	25	7	258	367	25	194
	Max.	52	7.5	8.8	13.0	2.4	2,300	80	32	12	279	400	90	210
	Min.	48	3.0	8.3	11.1	0.9	220	< 20	18	3	204	250	9	158
RR-39	Avg.	1524	5.7	8.6	11.7	3.5	2520	27	51	12	210	303	51	177
	Max.	1650	7.0	8.8	12.4	4.3	10,900	70	70	17	271	370	85	193
	Min.	1150	5.0	8.4	11.1	2.2	490	< 20	39	8	200	270	16	66
RL-42	Avg.	1106	6.3	7.9	10.6	3.1	31,000	6,850	31	8	175	260	3	86
	Max.	1230	9.0	8.3	11.4	4.3	79,000	14,000	38	16	182	330	10	135
	Min.	880	5.0	7.7	9.9	2.4	4,900	2,300	24	3	151	230	2	60
RL-43	Avg.		6.6	7.9	11.2	5.6	58,900	11,200	31	9	178	248	3	76
	Max.		10.0	8.3	12.3	7.6	540,000	33,000	38	14	184	280	4	93
	Min.		10.4	7.7	10.5	4.4	17,000	4,900	23	3	170	230	2	53

Table 1-C

Red River of the North

January 1965

Summary of Field Data

Station		Flow cfs	Temperature °C	pH	Dissolved Oxygen mg/1	5-Day 20° C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR- 9	Avg.	189	0	8.0	12.7	1.8	530	450	8	4	267	281	5	31
	Max.	195	0	8.3	13.1	2.5	1,700	1,700	20	10	289	330	6	35
	Min.	185	0	7.9	12.3	1.0	230	220	5	0	249	260	4	29
RR-10	Avg.	194	0	8.1	11.1	8.4	162,000	61,000	8	5	259	259	9	40
	Max.	200	0	8.2	11.7	18.9	540,000	140,000	15	5	283	300	13	41
	Min.	190	0	7.9	10.2	4.9	79,000	22,000	5	5	243	250	7	36
RR-11	Avg.	190	0	8.0	9.8	7.8	83,500	34,000	11	8	258	273	10	39
	Max.	195	0	8.1	10.6	17.4	230,000	130,000	35	15	268	290	20	45
	Min.	185	0	7.9	8.8	3.3	33,000	23,000	5	5	246	260	7	34
SH-13	Avg.	69	0	7.8	4.0	2.0	650	218	11	5	315	345	55	153
	Max.	75	0	8.0	6.0	3.4	4,900	1,700	20	5	374	410	80	170
	Min.	62	0	7.7	1.5	1.1	70	40	5	0	254	330	45	135
RR-14	Avg.	265	0	7.9	5.7	3.7	18,600	9,170	8	4	286	305	22	64
	Max.	270	1.0	8.1	6.7	8.6	33,000	23,000	20	10	310	330	45	88
	Min.	260	0	7.7	4.2	1.1	7,000	3,300	0	0	276	290	17	33
RR-15	Avg.	262	0	7.9	5.9	2.2	19,100	10,800	8	5	280	298	18	54
	Max.	265	0	8.0	6.3	2.7	35,000	24,000	10	5	283	300	19	72
	Min.	260	0	7.8	5.6	1.9	4,900	4,900	5	5	276	290	17	29
RR-16	Avg.	260	0	7.9	5.0	2.7	7,800	5,160	5	5	282	303	21	73
	Max.	265	0	8.1	8.5	5.0	24,000	13,000	10	5	302	320	25	88
	Min.	255	0	7.7	3.4	1.9	3,300	2,300	0	0	274	300	17	70
WH-17	Avg.	33	0	7.7	6.9	1.4	10,800	3,780	8	7	358	365	2	38
	Max.	34	0	7.8	7.8	2.8	35,000	7,900	10	10	362	370	3	40
	Min.	32	0	7.4	6.5	0.8	3,300	1,300	5	5	354	360	2	36
RR-18	Avg.	292	0	7.9	4.9	2.7	6,140	2,950	11	6	291	309	19	75
	Max.	292	0	8.1	7.4	5.4	13,000	4,900	25	10	310	330	22	86
	Min.	291	0	7.6	3.6	1.9	2,300	1,300	5	5	279	300	17	69
RR-19	Avg.	295	0	7.8	3.1	3.9	9,900	3,930	8	5	290	312	18	72
	Max.	295	1.0	7.9	4.0	8.1	17,000	7,900	10	5	293	320	21	80
	Min.	295	0	7.6	2.4	1.6	7,000	1,700	5	5	286	300	14	67
RR-20	Avg.	300	0	7.8	3.7	3.2	3,500	1,970	11	5	296	319	21	76
	Max.	300	0	8.0	4.2	8.1	7,000	4,600	25	5	314	340	24	89
	Min.	300	0	7.7	2.5	1.0	1,700	790	5	5	280	310	17	72
RR-21	Avg.	312	0	7.9	4.7	2.7	4,760	2,600	13	3	302	329	20	78
	Max.	315	0	8.0	8.4	8.2	11,000	4,900	20	10	339	380	25	94
	Min.	305	0	7.7	2.5	1.2	1,800	1,700	10	0	287	310	16	74

Table 1-C (Cont.)

Red River of the North

January 1965

Summary of Field Data

Station		Flow cfs	Temperature °C	pH	Dissolved Oxygen mg/1	5-Day 20°C. BOD mg/1	Coliform Bacteria Total MPN/100 ml	Coliform Bacteria Fecal MPN/100 ml	Suspended Solids Total mg/1	Suspended Solids Volatile mg/1	Alkalinity mg/1	Hardness mg/1	Chlorides mg/1	Sulfates mg/1
RR-22	Avg.	315	0	7.8	3.4	3.3	1,600	820	7	3	295	320	21	78
	Max.	315	0	7.9	7.1	7.7	3,300	1,700	10	5	299	320	22	80
	Min.	315	0	7.7	0.9	1.3	790	490	5	0	287	320	19	74
RR-23	Avg.	315	0	7.8	3.0	1.5	1,280	590	6	3	291	317	20	75
	Max.	320	0	7.9	5.0	2.2	3,300	1,100	10	5	300	320	22	80
	Min.	310	0	7.6	2.6	0.8	490	590	0	0	287	310	17	69
GFWP	Avg.	-	2.8	7.8	2.4	1.4	1,100	340	6	5	293	315	20	76
	Max.	-	4.5	7.9	2.6	1.6	4,900	790	10	5	295	320	22	82
	Min.	-	1.6	7.7	2.0	1.1	300	170	5	5	288	310	18	69
RL-26	Avg.	647	0	8.0	11.6	1.3	4,500	1,560	10	5	183	208	2	15
	Max.	655	0	8.3	12.4	2.0	11,000	2,300	10	5	199	210	3	16
	Min.	630	0	7.9	11.2	0.6	2,300	790	10	5	130	200	1	14
RR-27	Avg.	955	1	7.9	8.8	2.2	4,870	1,900	13	5	228	246	7	38
	Max.	970	0	8.1	10.0	2.9	11,000	4,900	20	5	231	250	8	42
	Min.	940	1	7.6	8.4	1.8	2,300	1,100	10	5	221	240	7	33
RR-30	Avg.	947	0	7.9	10.8	1.7	17,000	3,700	7	5	230	248	7	40
	Max.	965	0	7.9	11.2	2.6	24,000	9,400	10	5	234	250	8	44
	Min.	935	0	7.7	10.4	1.2	9,400	1,300	5	5	224	240	7	35
RR-31	Avg.	940	0	7.9	10.8	1.8	25,200	2,400	8	2	229	246	10	41
	Max.	950	0	8.0	11.7	2.2	160,000	4,900	10	5	233	250	10	43
	Min.	935	0	7.7	10.3	1.4	9,000	1,300	5	0	222	240	9	37
RR-34	Avg.	928	0	7.9	10.4	1.7	8,850	820	8	7	229	246	11	43
	Max.	935	0	8.1	10.7	2.7	14,000	7,900	10	10	236	260	12	41
	Min.	925	0	7.7	10.2	1.0	7,900	400	5	5	224	220	10	45
RR-36	Avg.	922	0	7.9	10.2	1.2	8,910	800	10	8	234	258	32	49
	Max.	930	0	8.0	10.5	1.5	17,000	2,300	10	10	236	270	36	54
	Min.	920	0	7.6	10.1	0.8	4,900	330	10	5	232	260	29	44
PR-38	Avg.	5.0	0	7.8	6.6	1.6	3,200	1,000	12	8	364	518	19	160
	Max.	5.2	0	8.0	6.9	2.9	13,000	3,300	20	10	395	530	20	170
	Min.	4.9	0	7.6	6.1	0.4	490	230	5	5	296	500	19	153
RR-39	Avg.	898	0	7.9	11.9	1.3	4,800	540	7	5	238	270	38	54
	Max.	910	0	8.1	12.5	1.9	7,900	1,100	10	5	244	270	40	58
	Min.	880	0	7.6	11.6	0.8	1,800	230	5	5	232	270	37	48

Table 2-4
Summary of Industrial Waste Samples
Red River of the North

	Flow (MGD)	Temp. °C. Influent	Temp. °C. Effluent	Ash Flume Flow	Ash Flume Temp. °C.	pH Influent	pH Effluent	pH Ash Flume	Suspended Solids Determination Influent Total mg/1	Suspended Solids Determination Influent Volatile mg/1	Suspended Solids Determination Effluent Total mg/1	Suspended Solids Determination Effluent Volatile mg/1	Phenols (mg/1) Influent	Phenols (mg/1) Effluent	5-day 20°C. BOD Influent mg/1	5-day 20°C. BOD Effluent mg/1	5-day 20°C. BOD Ash Flume mg/1	Coliform Data Influent Total MPN/100 ml	Coliform Data Influent Fecal MPN/100 ml	Coliform Data Effluent Total MPN/100 ml	Coliform Data Effluent Fecal MPN/100 ml
Moorhead Sugar Plant																					
	3.0	46	17			-			7830	1010	200	80			1515	506		1,600,000	1,600,000	1,700,000	1,700,000
	3.0	47	14.5			8.4	7.1								980	531		230,000	33,000	3,500,000	3,500,000
	-	46	13	-	37	8.5	7.2	9.0	3500	620	126	66			420	332	25.0	330,000	79,000	790,000	790,000
	2.2	47	16		43	8.3	7.3	8.8							900	425	58.5	490,000	31,000	1,300,000	790,000
Avg.	2.7	46.5	15	-	40	8.4	7.2	8.9	5566	815	163	73			954	449	42				
East Grand Forks Sugar Plant																					
	5.0	36	8.5			8.7	7.6		4890	264	76.5	48.0			285	192		3,480,000	230,000	7,900	790
	4.75	37	9.5			9.2	8.0		4960	612	50.0	33.0	18.0	5.0	249	166		9,200,000	1,720,000	20,100	1,300
	4.75	39	9.5	-	-	8.7	7.8		5810	868	55.0	43.5			346	182		4,900,000	230,000	22,100	2,300
	4.75	38	7.5			8.7	7.9		4270	668	43.0	29.5			328	170		3,450,000	230,000	92,000	2,120
	4.75	36	7.0			9.0	8.0		3580	516	43.5	26.0	15.2	9.6	246	108		6,300,000	110,000	20,100	1,720
Avg.	4.8	37.5	8.5	-	-	8.9	7.9		4690	578	53.6	36	16.6	7.3	291	164					
Crookston Sugar Plant																					
	3.25	40	13.5	.089	85	7.9	7.4	7.4	-	-	-	-			275	388	-	1,100,000	70,000	3,500,000	1,300,000
	-	-	-	-	-	8.8	7.6	7.7							388	606	> 157	1,700,000	49,000	3,500,000	1,300,000
	3.30	40	10	.025	85	8.4	7.5	7.9	-	-	42	20			332	506	> 175	1,300,000	130,000	3,500,000	,100,000
	3.30	43	8	-	82	8.9	7.4	7.6							419	612	75.8	170,000	33,000	790,000	790,000
	-	44		.097	82	8.9	7.5	8.1	5330	660	90	50			356	600	195	49,000	22,000	5,400,000	3,500,000
Avg.	3.28	42	10.5	.067	83.5	8.7	7.5	7.7	5330	660	66	35			354	542					

Table 2-4 (Cont.)

Industrial Wastes
Bacteriological Results

Red River of the North

	ACS - Moorhead Total	ACS - Moorhead Fecal	ACS - E.Grand Forks Total	ACS - E.Grand Forks Fecal	ACS - Crookston Total	ACS - Crookston Fecal	Roger Bros. Potato Total	Roger Bros. Potato Fecal	Pillsbury Potato Total	Pillsbury Potato Fecal	State Mill Total	State Mill Fecal	Frito Lay Total	Frito Lay Fecal
	-	-	-	-	16,000,000	5,400,000	3,300,000	230,000	< 200	< 200	7,900,000	490,000		
	5,400,000	3,500,000	2,200	< 200	13,000,000	4,900,000	9,200,000	1,300,000	13,000	4,900	4,900,000	1,300,000		
	1,300,000	790,000	3,100	80	13,000,000	1,300,000	>160,000,000	160,000,000	< 2,000	< 2,000	3,400,000	500,000		
	3,300,000	1,100,000	10,900	490	3,300,000	790,000	4,600,000	200,000	20	< 20	490,000	220,000		
	490,000	31,000	10,900	330	1,700,000	170,000								
	460,000	330,000	17,200	460	24,000,000	2,200,000	172,000,000	330,000	< 20	< 20	27,500,000	1,300,000		
	-	-	22,100	1,300	24,000,000	2,900,000	49,000,000	1,410,000	< 20	< 20	1,300,000	540,000		
	170,000	80,000	28,100	2,300	7,900,000	700,000	79,000,000	790,000	> 160,000	> 160,000	1,300,000	130,000	740,000	< 2,000
	20,000	< 20,000	92,000	2,120	3,300,000	460,000	27,800,000	170,000	> 160,000	> 160,000	7,900,000	1,300,000	230,000	2,000
	1,700,000	1,300,000	29,100	1,720	490,000	490,000	13,000,000	1,720,000	< 20	< 20	2,400,000	330,000	1,300,000	7,900
	790,000	790,000	24,100	1,720			340,000,000	330,000	< 20	< 20	9,200,000	790,000	330,000	500
	3,500,000	3,500,000	24,000	2,100	2,200,000	1,300,000	921,000,000	330,000	33,000	4,900	11,000,000	330,000	490,000	17,500
	1,700,000	1,700,000	4,000	1,300	7,000,000	4,900,000	130,000,000	490,000	2,200	1,720	3,300,000	330,000	130,000	200
	5,400,000	5,400,000	17,200	490	13,000,000	490,000	240,000,000	130,000	< 20	< 20	4,900,000	790,000	172,300	500
	-	-	10,900	1,300	> 160,000,000	>160,000,000	70,000,000	330,000	20	< 20	34,000,000	130,000	172,000	200
					7,900,000	790,000								
MEAN	940,000	797,000			6,960,000	1,400,000	56,300,000	609,000			4,940,000	534,000		

Table 2-8

Summary of Industrial Waste Samples
Red River of the North

	Flow (MGD) Flume	Temp. °C Flume	Flow (MGD) Process	Temp. °C. Process	Phenols Effluent mg/l	pH		Suspended Solids Determination				5-day 20°C. BOD			
								Flume		Process		mg/l		lbs/day	
						Flume	Process	Total mg/l	Volatile mg/l	Total mg/l	Volatile mg/l	Flume	Process	Flume	Process
	Pillsbury Potato Plant														
	.46	10	-	20	7.8	7.9	11.7	618	282	4050	3480	74.8	1860	286	4500
	.50	12	.29	24		4.8	12.2	302	83	4580	3910	34.2	3180	148	7700
	.50	10	.29	23		8.1	12.3	444	122	5010	5130	40.3	4000	205	11300
	.50	11	-	23		7.7	11.7	639	165	704*	552*	62.5	1410	261	3410*
Avg.	.49	10.5	.29	22.5	8.4	7.1	11.9	501	148	4840	4130	55.2	2783	223	7033

*Treated

Table 2-C

Summary of Industrial Waste Samples

Red River of the North

	Flow (MGD)	Temp. °C.	Suspended Solids Total mg/l	Suspended Solids Volatile mg/l	pH	5-day 20°C BOD mg/l	5-day 20°C BOD lbs/day
Rogers Brothers Potato Company							
	.20	19	10,800	3,060	6.7	4770	7950
	.31	22	11,200	7,180	7.8	6240	16100
	.17	20	492	255	5.3	1620	2300
Avg.	.23	20	7,497	3,498	6.6	4210	8783

Table 3-A

Bottom Organism Data
Number of Kinds and Number per Square Foot
Red River of the North
September 1964

River Mile	Red River of the North																	
	536 RR-4		[illegible] RR-5		483 RR-6		472 RR-7		462 RR-9		441 RR-10		436 RR-11		426 RR-12		416 RR-14		403 RR-15
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	1	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*
Mayflies																				
Sprawlers	5	15	4	19	2	*	2	*	2	*	1	*	1	*	2	*	2	*	4	10
Burrowers	1	41	1	5	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-
Caddisflies	2	*	2	14	1	*	1	*	1	*	-	-	-	-	2	*	1	126	1	20
Riffle Beetles	1	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-
Black Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	1	*	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	1	*	-	-	-	-	-	-	-	-
Clams	1	2	-	-	1	2	-	-	-	-	-	-	1	8	-	-	-	-	-	-
Midges	1	3	-	-	1	*	1	*	-	-	-	-	-	-	-	-	-	-	1	*
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	-	-	-	-	-	-	-	-	-	-	1	8	1	*	-	-	-	-	-	-
Leeches	1	2	-	-	-	-	-	-	-	-	1	*	1	*	1	*	1	3	1	2
Horsehair Worms	-	-	-	-	-	-	-	-	1	*	-	-	-	-	-	-	1	*	-	-
Sludgeworms	1	3	-	-	1	*	1	*	1	4	1	32	-	-	1	8	1	2	-	-
Total	14	69	7	38	6	-	5	-	7	11	5	43	4	11	6	10	8	137	8	34

*Collected in qualitative sample, counted as 1 in total.

Table 3-A (Cont'd.)

Bottom Organism Data
Number of Kinds and Number Per Square Foot
Red River of the North
September 1964

	Red River of the North																			
River Mile	386		375		357		347		335		319		305		298		292		286	
	RR-16		RR-18		RR-19		RR-20		RR-21		RR-22		RR-23		RR-27		RR-28		RR-29	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	1	*	1	*	2	4	1	*	1	3	2	*	-	-	1	*	1	*	-	-
Mayflies																				
Sprawlers	4	*	3	4	2	3	-	-	2	6	3	*	2	*	3	10	2	*	3	*
Burrowers	1	*	-	-	3	27	2	7	1	2	-	-	1	2	2	10	2	2	-	-
Caddisflies	1	3	1	2	1	2	2	*	-	-	-	-	-	-	1	*	1	*	-	-
Riffle Beetles	-	-	-	-	-	-	1	7	-	-	1	*	-	-	-	-	1	*	1	*
Black Flies	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	1	*	1	*	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	1	*	1	*	1	*	1	*	-	-	-	-	1	2	-	-	-	-
Midges	-	-	1	*	1	*	1	3	-	-	-	-	-	-	-	-	-	-	1	8
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-
Leeches	-	-	1	*	1	*	-	-	-	-	-	-	-	-	-	-	1	*	1	*
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	5	1	5	1	5	1	3	1	2	1	3	1	*	1	2	1	5	1	12
Total	9	16	9	15	12	44	9	23	6	14	8	10	5	-	10	28	10	14	7	25

*Collected in qualitative sample, counted as 1 in total.

Table 3-A (Cont'd)

Bottom Organism Data
Number of Kinds and Number Per Square Foot
Red River of the North
September 1964

River Mile	Red River of the North														Sheyenne		Wild Rice, Minn.		Red Lake River	
	279		274		254		236		208		176		158		1		3		66	
	RR-30		RR-31		RR-32		RR-34		RR-36		RR-37		RR-39		SH-13		WM-7		RL-24	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	-	-	-	-	1	*	-	-	-	-	-	-	-	-	1	*	2	*
Mayflies																				
Sprawlers	4	*	3	*	4	*	1	*	3	*	5	8	2	*	1	5	3	*	2	*
Burrowers	-	-	-	-							1	24	1	[illegible]					3	7
Caddisflies	1	*	1	*	1	*	-	-	-	-	2	5	-	-	2	14	2	*	-	-
Riffle Beetles	-	-	1	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*
Black Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	-	-	-	-	1	*	1	*	-	-	-	-	1	3	-	-	1	*
Midges	1	4	-	-	-	-	-	-	-	-	-	-	1	*	-	-	-	-	1	*
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leeches	-	-	1	8	-	-	-	-	-	-	-	-	-	-	1	8	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-	-	1	8	-	-
Sludgeworms	1	4	1	8	1	8	-	-	1	8	-	-	1	5	-	-	1	4	-	-
Total	7	13	7	19	6	13	3	3	6	16	8	37	5	13	6	31	9	18	10	14

*Collected in qualitative sample, counted as 1 in total.

Table 3-A (Cont'd.)

Bottom Organism Data
Number of Kinds and Number Per Square Foot
Red River of the North
September 1964

River Mile	Red Lakes River				Forest		Park		Pembina		Otter Tail River								Bois De Sioux		Wild Rice, N.D.	
	28		0.2		7		5		0.5		59		42		80		2		9		8	
	RL-25		RL-26		FR-33		PR-35		PE-38		OT-40		OT-41		OT-2		OT-3		BD-1		WD-8	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	1	*	2	*	-	-	1	*	-	-	-	-	1	*	-	-	1	*	-	-	-	-
Mayflies																						
Sprawlers	1	*	3	*			1	*	1	*	2	27	1	*	3	*	4	16	1	2	-	-
Burrowers	3	76					2	*	1	*			1	*	2	42			2	6	-	-
Caddisflies	1	*	-	-	-	-	1	*	2	*	-	-	2	*	3	7	3	33	-	-	-	-
Riffle Beetles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-
Black Flies	-	-	-	-	-	-	-	-	1	*	-	-	-	-	-	-	-	-	-	-	-	-
Alder Flies	1	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	1	4	1	*	-	-	1	*	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-	-	-	1	*	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-
Clams	-	-	-	-	-	-	1	*	-	-	1	*	-	-	-	-	-	-	-	-	-	-
Midges	-	-	-	-	-	-	1	76	1	*	-	-	-	-	1	2	-	-	-	-	-	-
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	-	-	-	-	1	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leeches	-	-	-	-	1	4	-	-	-	-	1	*	-	-	-	-	-	-	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	*	1	4	1	24	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-
Total	7	81	6	9	4	40	8	83	6	6	5	30	6	6	9	54	10	54	5	10	-	-

*Collected in qualitative sample, counted as 1 in total.

Table 3-B

Bottom Organism and Algal Data
Number of Kinds and Number Per Square Foot
Red River of the North
November 1954

River Mile	536 RR-4		501 RR-5		483 RR-6		472 RR-7		Red River of the North 462 RR-9		441 RR-10		436 RR-11		426 RR-12		416 RR-14		403 RR-15	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	1	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mayflies																				
Sprawlers	2	*	2	*	2	*	1	*	1	*	-	-	-	-	-	-	1	*	1	*
Burrowers	-	-	-	-	-	-	-	-	1	*	-	-	-	-	-	-	-	-	-	-
Caddisflies	2	*	2	*	-	-	1	*	1	*	-	-	-	-	-	-	1	605	1	*
Riffle Beetles	-	-	-	-	-	-	1	*	1	4	-	-	-	-	-	-	-	-	-	-
Black Flies	1	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	1	7
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges	1	*	1	*	1	*	1	*	-	-	-	-	1	12	1	216	1	7	1	4
Sewage Flies	-	-	-	-	-	-	-	-	-	-	1	12	1	4	-	-	-	-	-	-
Bloodworms	-	-	-	-	-	-	-	-	1	8	1	4	1	96	1	196	1	7	1	14
Leeches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	80	1	20
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	-	-	-	-	1	*	-	-	1	4	1	12	1	80	1	1116	1	218	1	598
Total	6	-	6	-	4	-	4	-	6	19	3	28	4	192	4	1492	6	858	7	645
Algae No./ml									2500		4700		8200		7100				7000	

*Collected in qualitative sample, counted as 1 in total.

Table 5-B (Cont'd.)

Bottom Organism and Algal Data
Number of Kinds and Number Per Square Foot
Red River of the North
November 1964

	Red River of the North																			
River Mile	386		375		357		347		335		319		305		298		292		286	
	RR-16		RR-18		RR-19		RR-20		RR-21		RR-22		RR-23		RR-27		RR-28		RR-29	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	-	-	1	2	1	5	1	10	-	-	-	-	-	-	-	-	-	-
Mayflies																				
Sprawlers	1	2	1	51	2	27	2	15	-	-	1	*	3	34	2	*	-	-	-	-
Burrowers	1	7	1	153	1	14	1	14	1	20	1	8	-	-	-	-	-	-	-	-
Caddisflies	2	2	1	255	1	340	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Beetles	1	2	-	-	1	75	1	5	1	20	-	-	-	-	-	-	-	-	-	-
Black Flies	-	-	-	-	-	-	1	*	-	-	-	-	-	-	-	-	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	-	-	-	-	-	-	-	-	-	-	1	12	-	-	-	-	-	-
Midges	1	68	1	183	1	353	1	543	1	68	1	11	1	81	1	10	-	-	-	-
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	-	-	1	41	1	14	1	76	1	*	1	5	1	7	1	7	-	-	-	-
Leeches	1	3	1	2	-	-	1	2	-	-	-	-	-	-	1	2	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	75	1	97	1	27	1	87	1	31	1	72	1	12	1	265	-	-	1	28
Total	8	159	7	782	9	852	11	750	6	150	5	97	7	146	6	285	0	0	1	28

*Collected in qualitative sample, counted as 1 in total.

Algae No. /ml	9100	10900	19100	20950	27500	26700	35650	22050	14700	20750

Table 3-B (Cont'd.)

Bottom Organism and Algal Data
Number of Kinds and Number Per Square Foot
Red River of the North
November 1964

	Red River of the North														Sheyenne		Wild Rice, Minn.		Red Lake River	
River Mile	279		274		254		236		208		176		158		1		3		66	
	RR-30		RR-31		RR-32		RR-34		RR-36		RR-37		RR-39		SH-13		WM-17		RL-24	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*
Mayflies																				
Sprawlers	-	-	2	12	1	*	1	4	1	*	1	4	3	*	1	65	3	*	1	*
Burrowers	-	-			1	16			1	*	1	*	1	8			1	8		
Caddisflies	-	-	-	-	1	*	1	*	-	-	-	-	-	-	1	333	2	*	1	20
Riffle Beetles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	10
Black Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	48	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges	1	4	1	52	1	12	1	4	1	12	1	4	-	-	1	19	1	4	1	27
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	1	4	-	-	1	4	1	4	1	4	-	-	-	-	-	-	-	-	-	-
Leeches	-	-	1	4	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	20	1	608	1	192	1	88	1	108	1	8	1	124	1	8	1	52	1	14
Total	3	28	5	676	7	230	5	101	5	126	4	17	5	133	7	476	8	66	6	73

*Collected in qualitative sample, counted as 1 in total.

	279	274	254	236	208	176	158	1	3	66
Algae No./ml	18400	18400	14400	24250	27100		19000			

Table 3-B (Cont'd.)

Bottom Organism and Algal Data
Number of Kinds and Number Per Square Foot
Red River of the North
November 1964

River Mile	Red Lakes River				Forest		Park		Pembina		Otter Tail River				Bois De Sioux		Wild Rice, N.D.	
	28		0.2		7		5		0.5		20		2		9		2	
	RL-25		RL-26		FR-33		FR-35		PE-38		OT-2		OT-3		HD-1		WD-2	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mayflies																		
Sprawlers									2	*	2	*			1	*	2	*
Burrowers			1	8							1	*						
Caddisflies	-	-	-	-	-	-	-	-	1	34	2	*	1	*	-	-	2	*
Riffle Beetles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black Flies	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	*	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges	1	8	1	4	1	8	1	392	1	82	-	-	1	*	1	*	1	*
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	-	-	1	68	-	-	-	-	-	-	1	*	-	-	-	-	-	-
Leeches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	28	1	92	1	68	1	32	1	14	-	-	-	-	-	-	-	-
Total	2	36	4	164	2	76	2	424	5	131	7	-	3	-	4	-	5	-

*Collected in qualitative sample, counted as 1 in total.

Algae No./ml 6550

Table 3-C

Bottom Organism Data
Number of Kinds and Number Per Square Foot
Red River of the North
January 1965

River Mile	Red River of the North															
	462 RR-9		441 RR-10		436 RR-11		426 RR-12		416 RR-14		403 RR-15		386 RR-16		375 RR-18	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mayflies																
Sprawlers	1	*	-	-	-	-	-	-	-	-	1	*	1	2	2	5
Burrowers	1	4	-	-	-	-	-	-	-	-	1	8			1	8
Caddisflies	1	*	-	-	-	-	-	-	2	240	2	32	2	15	2	173
Riffle Beetles	-	-	-	-	-	-	-	-	1	14	1	*	-	-	-	-
Black Flies	-	-	-	-	-	-	-	-	1	7	-	-	1	*	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	32
Clams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges	1	24	-	-	-	-	1	72	1	88	1	401	1	48	1	92
Sewage Flies	-	-	1	*	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	-	-	-	-	-	-	1	64	-	-	1	3	-	-	-	-
Leeches	-	-	1	8	-	-	1	8	-	-	-	-	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	24	1	264	1	44	1	354	1	39	1	109	1	15	1	25
Total	5	54	3	273	1	44	4	498	6	388	8	555	6	81	9	340

*Collected in qualitative sample, counted as 1 in total.

Algae No./ml		570	850		1200	625	450	850

Table 3-C (Cont'd.)

Bottom Organism Data
Number of Kinds and Number Per Square Foot
Red River of the North
January 1965

River Mile	357 RR-19		347 RR-20		335 RR-21		319 RR-22		305 RR-23		298 RR-27		279 RR-30		274 RR-31	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	1	*	-	-	-	-	-	-	-	-	-	-	-	-
Mayflies																
Sprawlers	2	5	1	2			1	*			1	20				
Burrowers	2	5	2	36	2	66										
Caddisflies	1	88	-	-	-	-	-	-	-	-	2	15	-	-	-	-
Riffle Beetles	1	41	1	20	1	12	-	-	-	-	1	2	-	-	-	-
Black Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges	1	212	1	569	1	398	1	53	-	-	1	83	1	44	1	71
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	1	3	1	148	1	7	1	49	1	100	-	-	-	-	-	-
Leeches	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	22	1	83	1	48	1	27	-	-	1	2	-	-	1	10
Total	10	378	8	859	6	531	4	130	1	100	6	122	1	44	2	81

*Collected in qualitative sample, counted as 1 in total.

Algae No./ml	310	360	360	420	700		620	520

Table 3-C(Cont'd.)

Bottom Organism Data
Number of Kinds and Number Per Square Foot
Red River of the North
January 1965

	Red River of the North						Sheyenne		Wild Rice,Minn.		Red Lakes River					
River Mile	254		236				1		3		66		28		0.2	
	RR-32		RR-34		RR-36		SH-13		WM-17		RL-24		RL-25		RL-26	
	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.	No. Kinds	No. Sq. ft.
Stoneflies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mayflies																
Sprawlers	1	*	1	*	1	*			1	4	1	5				
Burrowers	1	4	1	*	1	2			1	4						
Caddisflies	1	*	-	-	1	20	1	5	-	-	3	31	-	-	-	-
Riffle Beetles	-	-	-	-	1	3	1	5	-	-	1	2	-	-	-	-
Black Flies	-	-	-	-	-	-	-	-	1	*	-	-	-	-	-	-
Alder Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limpets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges	1	68	1	4	1	250	1	18	-	460	1	229	1	8	1	24
Sewage Flies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bloodworms	1	4	-	-	-	-	-	-	-	-	-	-	1	8	-	-
Leeches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horsehair Worms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	1	16	1	28	-	-	1	20	1	260	1	2	1	22	1	44
Total	6	94	4	34	5	276	4	48	4	729	7	269	3	38	2	68

*Collected in qualitative sample, counted as 1 in table.

Algae No./ml 830 310 950 150

APPENDIX II

TECHNICAL APPENDIX

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TECHNICAL APPENDIX

INTRODUCTION

The capacity of a stream to assimilate pollution is a function of several interrelated factors involving hydrology, biological satisfaction, natural purification, and stream biota. If each factor can be reasonably defined and its importance in the stream balance shown, it should, theoretically, be possible to vary these conditions and note the effect on the dependent measure of water quality, whether it be dissolved oxygen or bacteriological indicator organisms. It is the purpose of this appendix to review the principles of self-purification with reference to organic wastes and to demonstrate the application of these principles to the determination of the pollutional capacity of streams.

HYDROLOGY

Expected River Flows

The U. S. Geological Survey maintains several recording gages in the Red River of the North study area. Those selected for analysis for this report are at Fargo, North Dakota, Crookston, Minnesota, and Grand Forks, North Dakota. From statistical relationships established between river flow and probability of occurrence, the mean expected discharge as well as the discharge below which values will occur once in ten years on a mean monthly basis were determined. These values are summarized in Table II-1.

Time of Travel

The reactions of unstable pollutional materials are functions of time. The satisfaction of B.O.D. and the dieoff of coliform bacteria proceed systematically with time of travel downstream from a source of waste. To describe the affected area over which pollution is occurring and to calculate effects based on the time of travel, cross sections of the river were obtained at every bridge within the study area during the September phase of the survey. These data, together with the river discharge data obtained from the U. S. Geological Survey, enabled the velocity between sampling stations to be calculated and estimates of time of travel to be made.

Table II-1

Most Probable Values of Stated Stream Flows in cfs Red River of the North and Red Lake River

Month	Mean Monthly	10-yr. Monthly Low Flow
Fargo, North Dakota		
January	203	80
February	203	100
March	380	210
April	880	340
May	760	325
June	930	205
July	740	210
August	330	90
September	240	65
October	200	63
November	190	68
December	180	75
Crookston, Minn.		
January	305	82
February	285	88
March	495	175
April	2600	640
May	1400	550
June	1220	420

Table II-1 (Cont.)

Most Probable Values of Stated Stream Flows in cfs

Red River of the North and Red Lake River

Month	Mean Monthly	10-yr. Monthly Low Flow
Crookston, Minn. (Cont.)		
July	720	240
August	380	93
September	480	112
October	430	128
November	390	125
December	335	68
Grand Forks, North Dakota		
January	540	185
February	530	220
March	1050	340
April	6200	2000
May	3350	1500
June	3400	1050
July	2100	550
August	970	250
September	920	265
October	790	280
November	710	265
December	610	205

Examination of the rating curves of several U.S.G.S. gaging stations showed a mathematically definable relationship between river discharge (Q) and velocity (V). In the range of flows, covered by the rating curves, river discharge is a function of velocity in the form:

$$Q_1 = Q_o \left[1 + 10^{k(V_1 - V_o)} \right] \qquad (1)$$

where:

Q_1 = discharge in cfs at velocity V_1 in fps

Q_o = discharge in cfs at velocity V_o in fps

k = constant rate at which Q is changing with V

Solution of this equation for the gaging stations at Fargo, North Dakota, Halstad, Minnesota and Grand Forks, North Dakota showed k values of .856/fps, .893/fps and .834/fps respectively, with a mean of .861/fps. Assuming this relationship to hold for the entire river system, the velocity occurring at any given discharge may be calculated using the observed river discharge and velocity at a given sampling station from the September survey. The accuracy of these estimates was demonstrated by the discharge of clean-up wastes from the American Crystal Sugar Company plant at Moorhead in January. This waste, with a B.O.D. value much higher than the two municipal treatment plant effluent traveled downstream as a slug and its movement was traced. From the outfall of the beet sugar plant to a point in the Red River near Climax, Minnesota, the observed time of travel of this slug was 8.0 days. The calculated estimate was 8.3 days.

The estimated times of travel for the three phases of this study are listed in Table II-2.

Table II-2
Estimated Times of Travel
Red River of the North & Red Lake River

Station	River Mile	Time of Travel (Days)		
		Sept.	Nov.	Jan.
Fargo-Moorhead to Grand Forks				
Fargo-Moorhead	448	0	0	0
RR-10	441	0.3	0.2	0.3
RR-11	436	0.5	0.4	0.4
RR-12	426	1.0	0.8	0.8
RR-14	416	1.6	1.2	1.3
RR-15	403	2.5	1.9	2.0
RR-16	386	4.2	3.0	3.3
RR-18	375	5.2	3.8	4.1
RR-19	357	7.3	5.3	6.0
RR-20	347	8.9	6.3	7.2
RR-21	335	10.1	7.3	8.3
RR-22	319	12.8	8.5	9.8
RR-23	305	18.3	10.7	12.3
RR-27	298	22.0	13.7	17.0
Grand Forks to International Boundary				
G.F. - E.G.F.	296	0	0	0
RR-28	292	0.8	0.3	0.4
RR-29	286	1.4	0.7	1.0
RR-30	279	2.3	1.2	1.7
RR-31	274	2.9	1.6	2.2
RR-32	254	5.1	2.9	4.1
RR-34	236	7.1	4.0	5.6
RR-36	208	9.5	5.6	7.7
RR-37	176	12.0	7.5	10.3
RR-39	158	14.2	8.8	12.1

Table II-2

Estimated Times of Travel

Red River of the North & Red Lake River

Station	River Mile	Time of Travel (Days)		
		Sept.	Nov.	Jan.
Crookston to Grand Forks (Red Lake River)				
Crookston	51	0	0	
RL-43	49		0.1	
RL-25	28	1.8	0.7	
RL-42	14	3.3	1.2	
RL-26	0	6.7	2.3	

WASTE ASSIMILATION

Many waste substances are chemically or biologically unstable and their rates of decrease can be predicted or measured directly. The concentration of dissolved oxygen, however, depends not only on the rate of oxidation of decaying organic matter but also on the rate of reaeration of the stream. The simultaneous action of deoxygenation and reaeration produces a pattern in the dissolved oxygen concentration along the stream known as the dissolved oxygen sag curve. This concentration pattern can be mathematically approximated by the differential equation

$$\frac{dD}{dt} = k_r L - k_2 D \qquad (2)$$

where: L = concentration of organic matter (B.O.D.)

k_r = rate of oxidation of organic matter

D = dissolved oxygen deficit from a saturated value

k_2 = rate of reaeration

$\frac{dD}{dt}$ = change of deficit with time

This equation states that the rate of change of dissolved oxygen in a stream is a function of two independent rates proceeding at the same time. The dissolved oxygen tends to be decreased by its use in the satisfaction of decaying organic matter and to be increased by reaeration from the atmosphere, which is a function of the hydraulic factors of the stream. Integration of equation (2) gives:

$$D_t = \frac{k_r L_o}{k_2 - k_r} \left(10^{-k_r t} - 10^{-k_2 t}\right) + D_o \left(10^{-k_2 t}\right) \qquad (3)$$

where: D_t = dissolved oxygen deficit at time t.

k_r = rate of oxidation of organic matter in the stream.

L_o = concentration of organic material (B.O.D.) in the stream just below the waste discharge.

t = time of travel in the stream.

Other factors such as photosynthesis, second stage B.O.D. demand or oxygen demand from bottom deposits may be incorporated into the original differential equation. The subsequent integration will yield an equation similar in form to equation (3), but with the inclusion of the effect of these additional variables upon the resulting dissolved oxygen deficit. This procedure was necessary in certain portions of the Red River and the results will be discussed in the evaluation of data from these areas.

The biochemical oxygen demand of a waste exerted in any interval of time is expressed by the equation:

$$Y_T = L_o \left(1 - 10^{-k_1 t}\right) \qquad (4)$$

where: Y_T = B.O.D. exerted at time t.

k_1 = rate of deoxygenation in a laboratory bottle.

L_o = ultimate or total amount of organic material available for oxidation.

The 5-day B.O.D. (Y_5) which is commonly reported is a measure of an indication of the total amount of B.O.D. available. Since it is this total amount of material that is depleting the oxygen resources of the stream, its value is necessary in the solution of the sag equation (Equation 3). This predicates a knowledge of the laboratory deoxygenation rate, k_1, for each sampling point through which the sag is to be calculated. There are methods available for a determination of this k_1 rate and these have been used in evaluating the B.O.D. data obtained in this survey. Consequently, the total quantity of B.O.D. available in the stream at each point of interest has been calculated. The rate of removal of B.O.D. in the stream (k_r) is given by

$$k_r = \frac{\mathrm{LOG}\ L_{o_1} - \mathrm{LOG}\ L_{1_2}}{t} \qquad (5)$$

where: L_{o_1} = ultimate B.O.D. at the upstream station in the reach.

L_{o_2} = ultimate B.O.D. at the downstream station in the reach.

t = time of travel through the reach.

The initial dissolved oxygen deficit (D.O.) may be determined from observed data. The reaeration coefficient (k_2) has been defined by several researchers as a function of velocity and depth. These measurable physical factors were obtained by cross sections at each station and representative values of k_2 through the reaches of interest were established.

The temperature influence of the deoxygenation and reaeration coefficients may be expressed as follows:

$$k_{T_2} = k_{T_1} \; \theta^{T_2 - T_1} \qquad (6)$$

where: k_{T_2} is the rate at temperature T_2

k_{T_1} is the rate at temperature T_1

For the deoxygenation rate, θ is equal to 1.047, and for the reaeration rate, θ has a value of 1.024.

The critical point of the dissolved oxygen sag equation is the minimum dissolved oxygen concentration or maximum deficit for a given waste loading. At this critical point the reaeration function exactly equals the deoxygenation function and the change of dissolved oxygen with respect to time is equal to zero from equation (2). Therefore, at this point:

$$k_r L = k_2 D$$

Expressing L in terms of waste input at the discharge point, tne equation becomes

$$k_r L_o \; (10^{-k_r t_c}) = k_2 D \qquad (7)$$

where t_c is the time of travel to the critical point.

The time, t_c, is

$$t_c = \frac{1}{k_2 - k_r} \; \mathrm{LOG} \left[\frac{k_2}{k_r} \left(1 - \frac{D_o (k_2 - k_r)}{k_r L_o} \right) \right] \qquad (8)$$

Therefore, the waste load, L_o, which may be discharged to maintain values of dissolved oxygen greater than or equal to an allowable minimum, may be calculated from Equations (7) and (8). Likewise, the value of dissolved oxygen which would result from a given waste discharge may also be calculated.

B.O.D. VALUES

To determine the ultimate first stage demand (L_o) at a particular station, it is necessary to know the rate at which satisfaction of organic material is taking place. This can not be obtained from the 5-day B.O.D. alone. If the classical first order reaction (Equation 4) is used, an additional 2-day B.O.D. permits solution for the k_1 rate by simultaneous equations as follows:

$$Y_2 = L_o (1 - 10^{-2k_1})$$

$$Y_5 = L_o (1 - 10^{-5k_1})$$

With the k_1 rate known, it becomes a simple matter to solve for the ultimate demand (L_o) by using the average 5-day B.O.D. at that sampling location. Two-day B.O.D.'s were collected on 20 percent of the samples at each station in November, 1964.

Daily B.O.D.'s were performed for twenty days at selected river stations and on the effluents from the Fargo municipal plant, the Moorhead sugar plant, and the Pillsbury potato plant at Grand Forks. These long-term B.O.D.'s were done to give a clearer picture of the actual rate of satisfaction and to illustrate any second stage demand.

Since river temperatures in November were near 5°C., the effect of the colder water will exert an inhibiting action on the rate of satisfaction of B.O.D. The commonly accepted temperature correction for k_1 rates is Equation 6 with θ equal to 1.047. There has been some questioning of the use of this factor to project to extremely cold temperatures, since it is believed that at 5° and below, psycrophilic or cold-loving bacteria become ascendant and supersede the mesophilic or intermediate temperature bacteria which had been accomplishing the degradation of the organic material. To test this hypothesis, simultaneous 2-day and 5-day B.O.D.'s were set up at 5°C. to compare with the 2-day and 5-day B.O.D.'s at 20°C. The value of Θ was then obtained from a knowledge of the respective k_1 rates. These values and the 20°C. k_1 rates as well as the rates from the long-term B.O.D.'s at 20°C. are shown in Table A-3. Although the results are quite varied and show a wide range, when plotted as a normal probability distribution the mean Θ is 1.047. The normal distribution plot is shown in Chart A-1.

Table II-3

Deoxygenation Rates (k_1)

Red River of the North & Red Lake River

Station	River Mile	k_1 Long Term 20°C.	k_1 20°	k_1 5°	θ
Red River of the North					
RR- 9	462	.10	.11	.01	1.149
RR-10	441	.20	.13	.25	.663
RR-11	436		.10	.24	.569
RR-12	426		.10	.04	1.065
RR-14	416		.08	.07	1.011
RR-15	403		.08	.11	.795
RR-16	386		.04	.09	.629
RR-18	375		.03	.03	1.029
RR-19	357	.06	.07	.08	.888
RR-20	347		.09	.02	1.106
RR-21	335		.11	.06	1.039
RR-22	319		.10	.01	1.169
RR-23	305	.09	.09	.02	1.098
RR-27	298		.10	.05	1.038
RR-28	292	.13	.12	.06	1.048
RR-29	286		.14	.03	1.106
RR-30	279		.12	.03	1.111
RR-31	274	.13	.10	.04	1.062
RR-32	254		.12	.02	1.113
RR-34	236		.12	.07	1.040
RR-36	208	.08	.12	.10	1.008
RR-37	176		.06	.07	.960
RR-39	158		.08	.08	.983

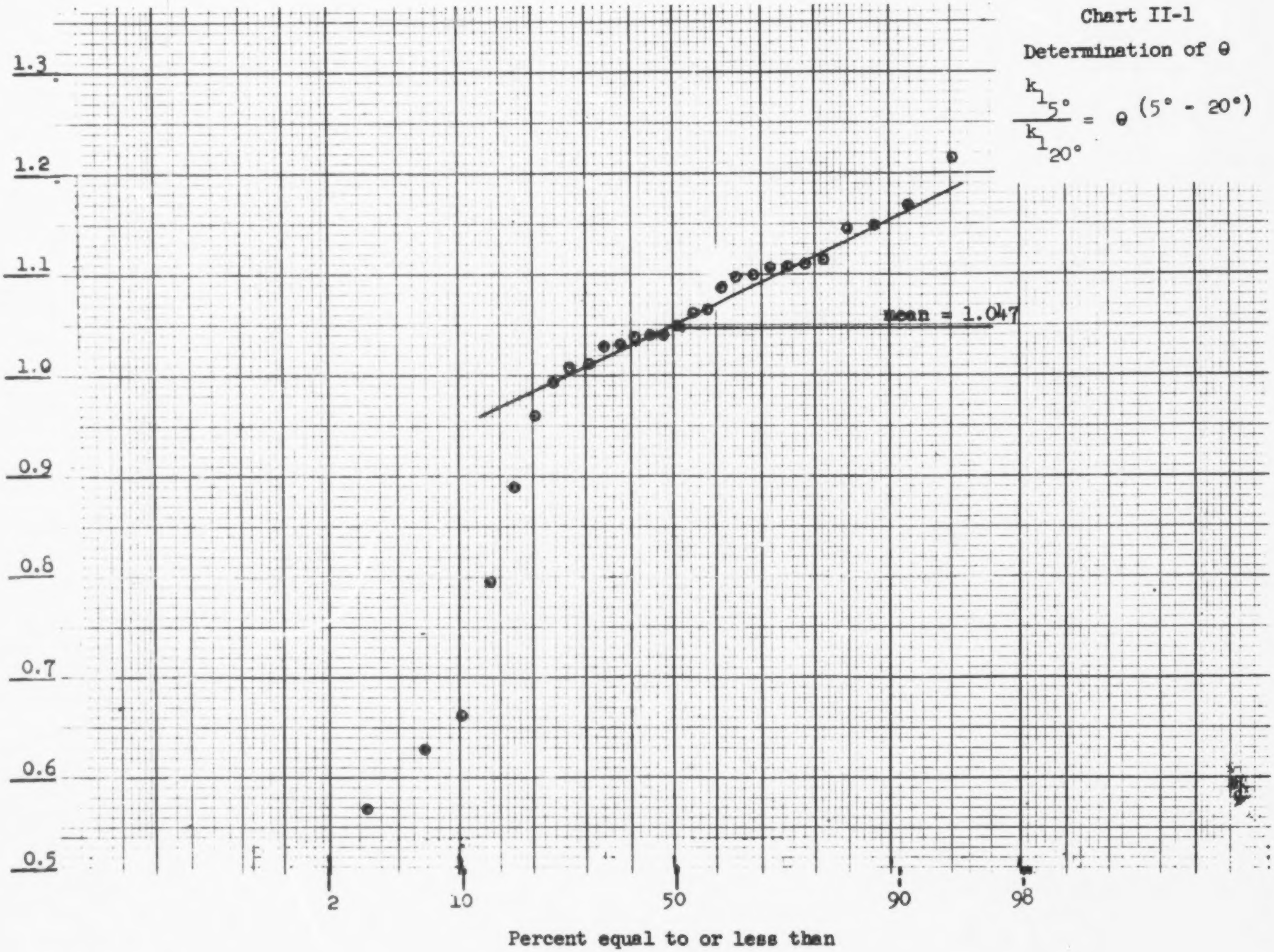
Table II-3 (Cont.)
Deoxygenation Rates (k_1)
Red River of the North & Red Lake River

Station	River Mile	k_1 Long Term 20°C.	k_1 20°	k_1 5°	θ
Red Lake River					
RL-24	298-66		.07	.02	1.095
RL-43	298-46		.14	.02	1.146
RL-25	298-28		.14	.09	1.031
RL-42	298-14		.14	.04	1.087
RL-26	298-0	.08	.09	.01	1.214

Chart II-1

Determination of θ

$$\frac{k_{1_{5^\circ}}}{k_{1_{20^\circ}}} = \theta\,(5^\circ - 20^\circ)$$



EVALUATION OF DATA

Red River of the North - Fargo to Grand Forks

When the American Crystal Sugar Company plant at Moorhead was discharging wastes, the B.O.D. in the river below Fargo-Moorhead exhibited an extremely rapid rate of decomposition. The B.O.D. remaining at Georgetown, Minnesota, 1.2 days time of travel downstream from the plant outfall, was about 27 percent of that observed below the outfall. Two factors account for this observation. The waste discharged by the American Crystal Sugar Company plant contained sugar, a readily oxidizable carbonaceous material. In addition, large slime-like growths, principally *Sphaerotilus natans* were observed in the stream through Georgetown. *Sphaerotilus natans* is a filamentous material which requires carbon for growth and readily absorbs carbonaceous organic matter for use as food. This slime growth was not prevalent during the September phase of the survey. In September, the carbonaceous material discharged from the municipal plants was about one-fifth the quantity in November, and this material was not in an easily oxidizable form, having been subjected to secondary treatment. The respiration of the slime growths in absorbing the B.O.D. was measured by means of light and dark bottles suspended in the stream in the same manner as that used to measure the production of oxygen by algae.

Also, when the sugar plant was discharging, large amounts of organic bottom deposits were observed in the stream bed from the waste outfalls to below the confluence with the Sheyenne River. These bottom deposits also exerted a significant oxygen demand.

Both the respiration of the slime growths and the effect of bottom demand were considered constant with time and were added to the basic differential equation (2)

$$\frac{dD}{dt} = k_r L - k_2 D + R_s + B \qquad (9)$$

where R_s = net respiration of the slimes

B = benthal or bottom demand

This differential equation integrates to:

$$D_t = \frac{k_r L_o}{k_2 - k_r}\left(10^{-k_r t} - 10^{-k_2 t}\right) + \frac{R_s}{k_2}\left(1 - 10^{-k_2 t}\right) + \frac{B}{k_2}\left(1 - 10^{-k_2 t}\right) + D_o\left(10^{-k_2 t}\right) \qquad (10)$$

Chart A-2 shows the ultimate B.O.D. values in pounds per day in the river versus time of travel in this stretch during November. The profile was constructed only from the waste sources to Georgetown, Minnesota, since at Georgetown the D.O. had recovered to a level greater than 5.0 mg/l. All waste sources were considered to be discharged at one point, river mile 448. The sharp increase in B.O.D. at 0.7 days is due to the residual B.O.D. in the Sheyenne River at the confluence of the two streams. The excessive rate of deoxygenation of the wastes in the river, plus the added demand from bottom deposits, combine to cause a rapid depletion of the dissolved oxygen. A D.O. profile was calculated from below the sources of waste to Perley, Minnesota, as is shown in Chart II-3. The values used in this calculation are summarized in Table II-4. Chart II-3 shows a minimum D.O. value of 1.5 mg/l to occur just before the confluence with the Sheyenne River.

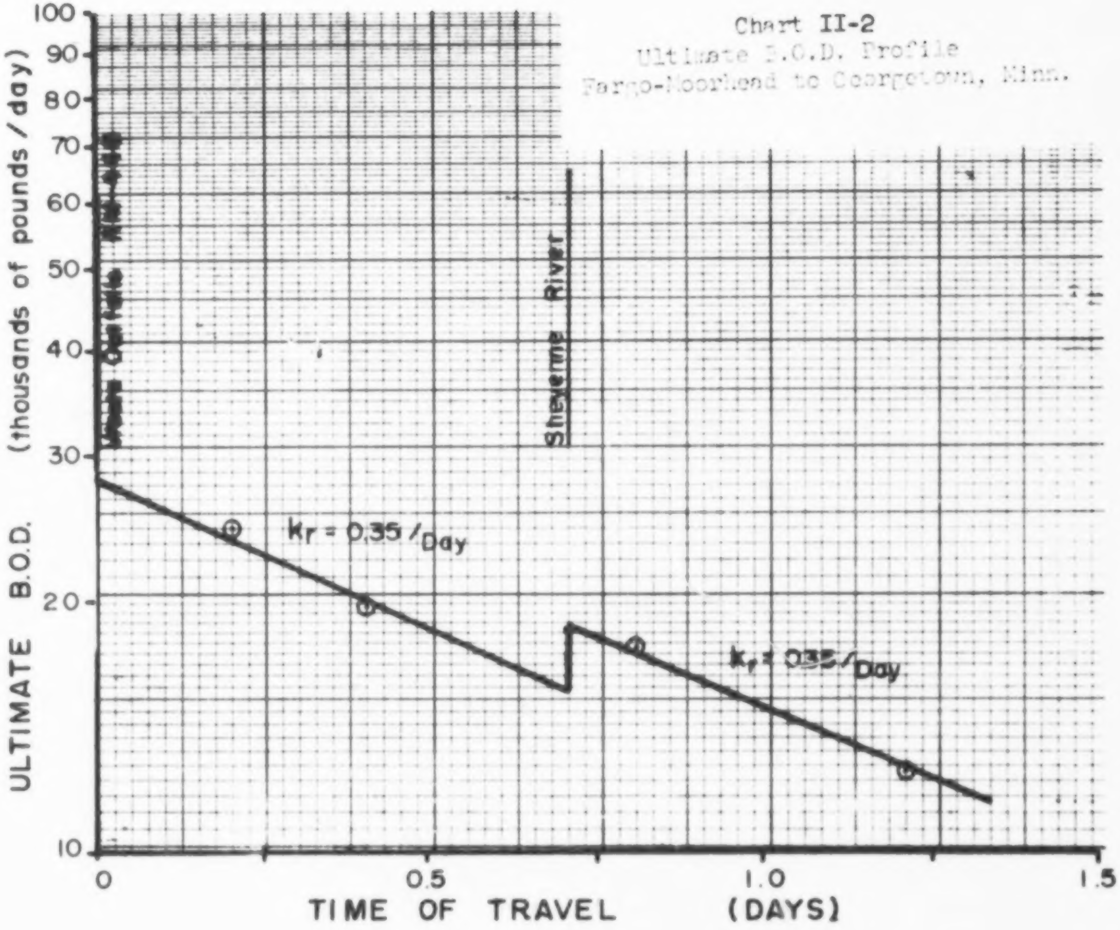


Chart II-2
Ultimate B.O.D. Profile
Fargo-Moorhead to Georgetown, Minn.

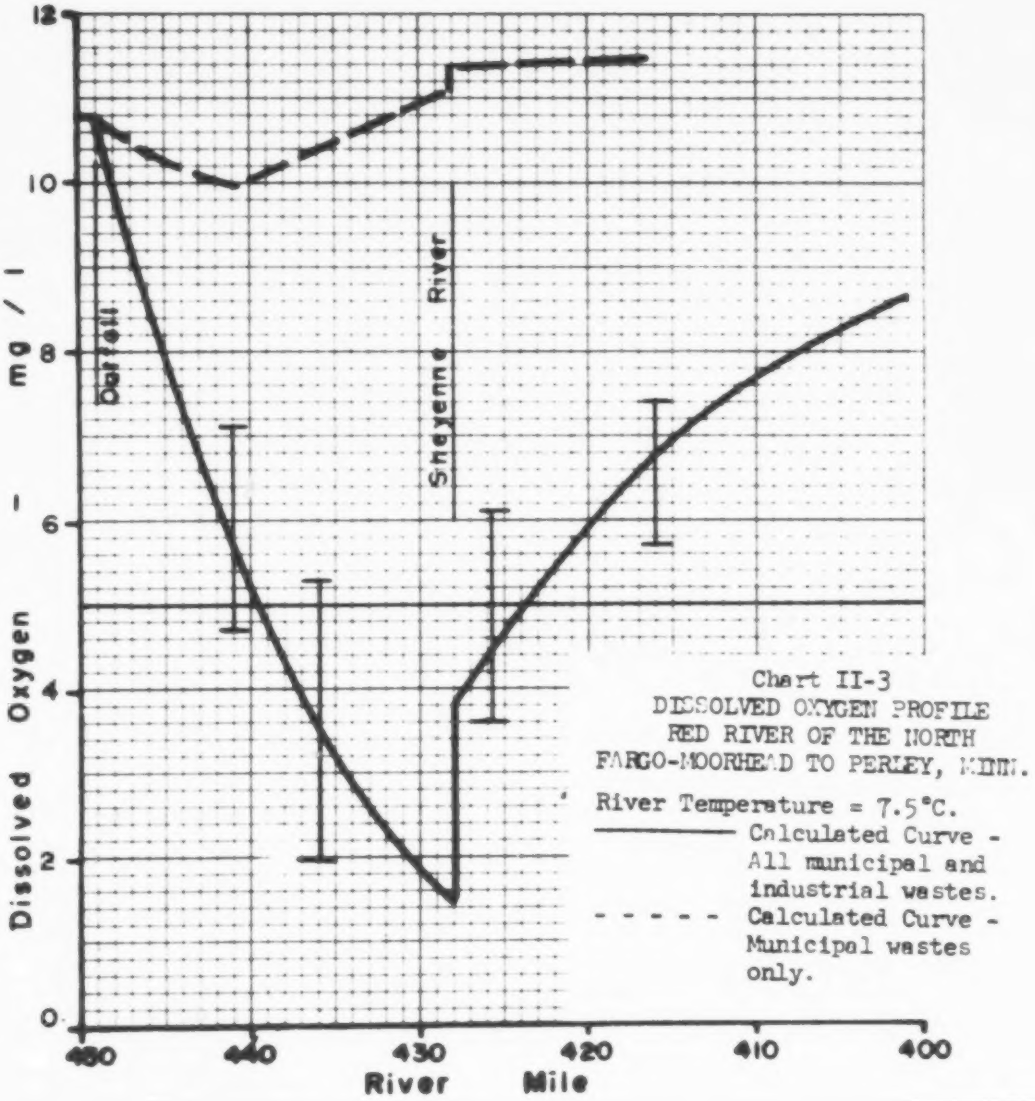


Chart II-3
DISSOLVED OXYGEN PROFILE
RED RIVER OF THE NORTH
FARGO-MOORHEAD TO PERLEY, MINN.

River Temperature = 7.5°C.

———— Calculated Curve - All municipal and industrial wastes.

- - - - - Calculated Curve - Municipal wastes only.

Table II-4

Values Used in Calculation of D.O. Profiles

Red River of the North - Fargo to Grand Forks

November Profile

Ultimate B.O.D. at Waste Outfalls (L_o)	27000 lbs/day
Deoxygenation Rate Constant (k_r)	.35/day
Reaeration Rate Constant (k_2)	.75/day
Residual Upstream Deficit of D.O. (D_o)	1550 lbs/day
Respiration of Slimes (R_s)	
R.M.448 to R.M.441	900 lbs/day
R.M.441 to R.M.436	867 lbs/day
R.M.436 to R.M.428	783 lbs/day
Benthal Demand (B)	
R.M.448 to R.M.441	7500 lbs/day
R.M.441 to R.M.428	21600 lbs/day
Ultimate B.O.D. contributed from Sheyenne R.	2700 lbs/day
River Temperature	7.5°C.

November Profile without Sugar Plant Discharge

Ultimate B.O.D. at Waste Outfalls (L_o)	11200 lbs/day
Deoxygenation Rate Constant (k_r)	.06/day
Respiration of Slimes (R_s)	0
Benthal Demand (B)	
R.M.448 to R.M.441	2820 lbs/day
R.M.441 to R.M.436	2030 lbs/day

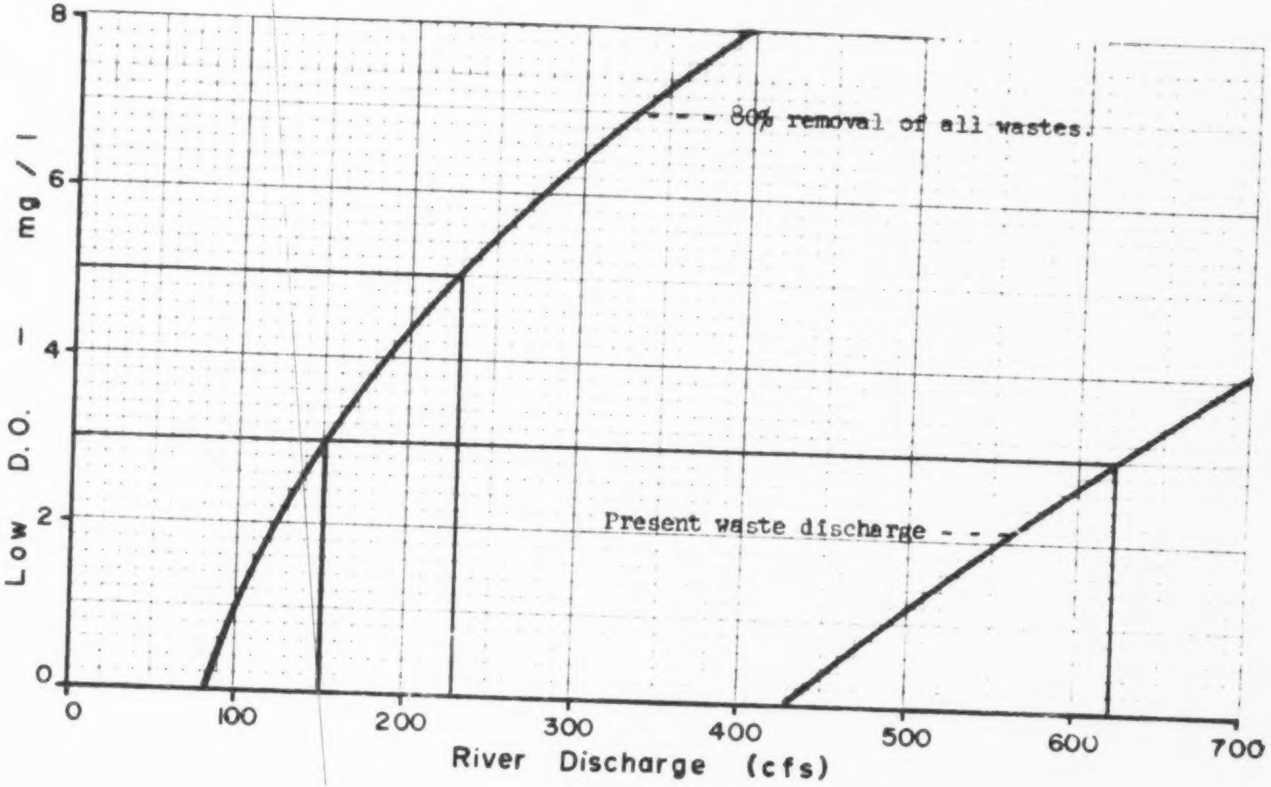
The sharp increase in D.O. results from the residual D.O. in the Sheyenne River. The D.O. remained below 5.0 mg/l for 16 miles in this stretch and would have remained below 5.0 mg/l for a greater distance except for the residual D.O. in the Sheyenne River.

The dashed curve represents a projection of the D.O. and B.O.D. values obtained in September at flows of 70 cfs to November at flows of 230 cfs, with appropriate transformation of the rate coefficients due to colder river temperatures. It is the best estimate of the probable D.O. sag curve through this critical stretch of river in November if the American Crystal Sugar Company plant at Moorhead had not been discharging its wastes. The values used in constructing this profile are also listed in Table A-4.

Chart A-4 illustrates the low D.O. that may be expected at any given river discharge for present waste loads and for 80 percent of waste removal at the most critical river temperature of 18°C. This is the highest river temperature at which all three waste sources may be discharging. These curves are based on the present discharges of 15,800 pounds per day of ultimate B.O.D. from the sugar beet plant and 7,700 pounds per day of ultimate B.O.D. from the combined effluents of the two municipal sewage treatment plants. The percentage removal is based on the total B.O.D. discharged, with no distinction between sources. The D.O. in the river will be severely depleted below the standard of 5.0 mg/l for continued discharge of the wastes with no abatement. To ensure 5.0 mg/l as a minimum D.O., stream flow exceeding 600 cfs would be necessary. This is far above any normal flow for this time of year (September) and is more than the regulating

Chart II-4
LOW D.O. vs RIVER DISCHARGE
RED RIVER OF THE NORTH
FARGO TO GRAND FORKS

River Temperature = 18°C.
All municipal and industrial wastes discharging.



facility at Orwell dam can reasonably supply. Even with 85 percent removal of all wastes, the stream flow required would exceed that normally expected. With total withholding of all sugar beet wastes, the minimum 5.0 mg/l of D.O. will not be achieved during the warm river temperature period for continued discharge of present municipal wastes at minimum river flows. Reduction of the present municipal treatment plant effluents must be accomplished when river discharge is below about 80 cfs in the warmer months and below 60 cfs in October and November. Chart II-5 indicates that at normally expected flows during the open water period of the beet processing campaign, no effluent can be tolerated from the sugar plant if the standard of 5.0 mg/l is maintained. Complete storage of all beet wastes during the entire campaign, for both open water and ice cover, with release in the spring runoff period, is necessary with present expected fall river flows. Furthermore, it can be shown from Table II-5 that for the mean expected spring runoff a further reduction of 10 percent in the B.O.D. must be accomplished so that all of the stored wastes may be released. During the once in ten year low monthly spring runoff, the present effluent load must be reduced a further 69 percent to maintain 5.0 mg/l in the river.

An alternative is low flow augmentation to permit the sugar plant to discharge the entire stored wastes without further treatment during the spring runoff. Inspection of Chart II-5 shows that for a guaranteed flow of 1000 cfs during the spring runoff, the entire stored wastes could be released by the middle of June. Since the once in

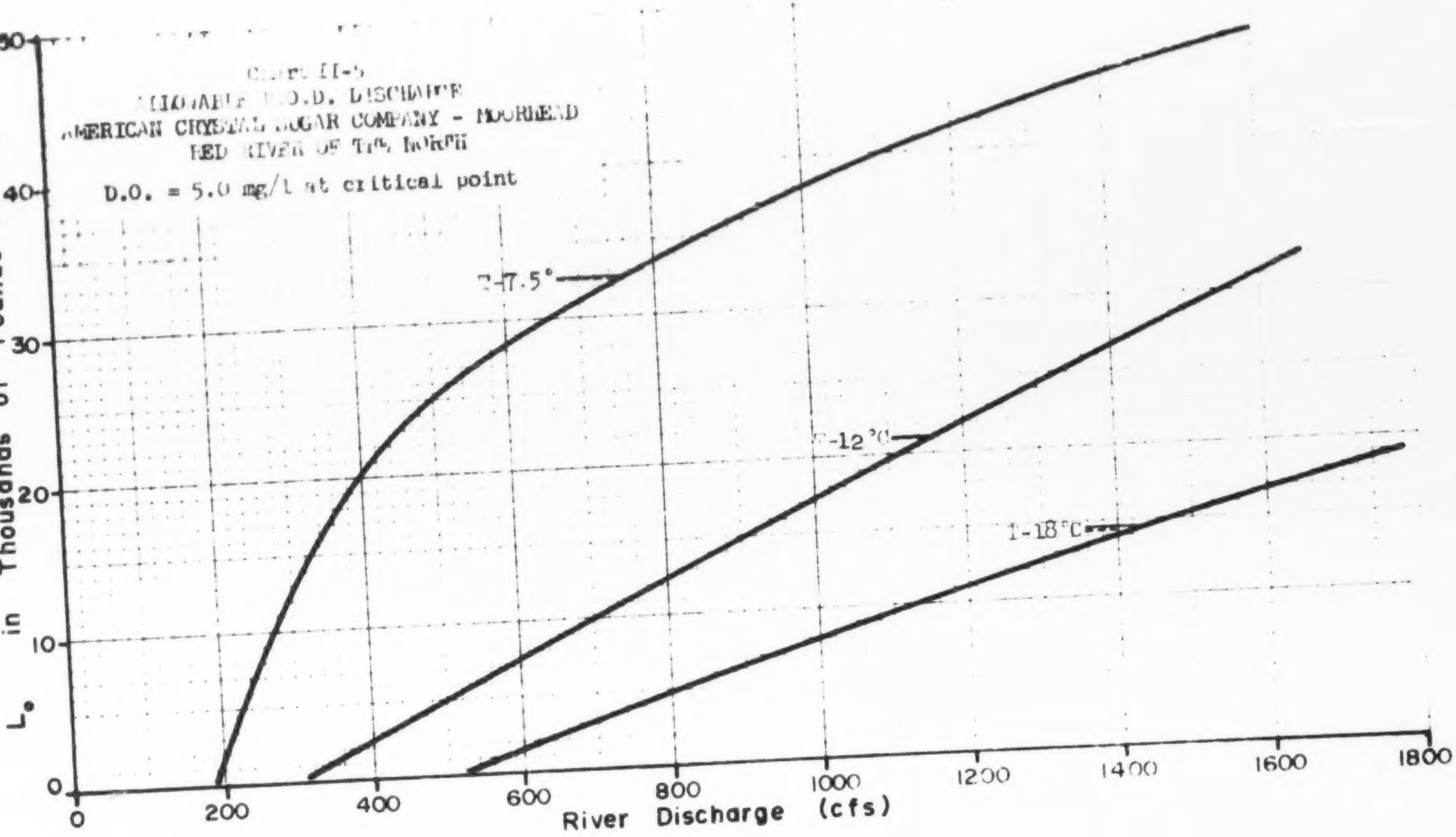


Chart II-5
ALLOWABLE B.O.D. DISCHARGE
AMERICAN CRYSTAL SUGAR COMPANY - MOORHEAD
RED RIVER OF THE NORTH

D.O. = 5.0 mg/l at critical point

Table II-5

Schedule of Spring Release
American Crystal Sugar Co. - Moorhead

Average operating season = 150 days at 4,000 tons/day

B.O.D. effluent = 3.0 lbs/ton of beets

Total stored B.O.D. = 1,800,000 lbs.

Month	Mean Flow cfs.	Avg. River Temp. °C.	B.O.D. Release lbs/day	Total B.O.D. Release lbs/month
Mean Spring Runoff				
April	880	7.5	35,500	1,060,000
May	760	12.0	11,500	357,000
June	930	18.0	7,000	210,000

Total B.O.D. that can be released = 1,627,000 lbs.

Necessary reduction = $\frac{173,000}{1,800,000}$ = 10%

Once in Ten Year Low Spring Flow = 350 cfs.

Month	Mean Flow cfs.	Avg. River Temp. °C.	B.O.D. Release lbs/day	Total B.O.D. Release lbs/month
April		7.5	17,000	510,000
May		12.0	1,500	46,500
June		18.0	0	0

Total B.O.D. that can be released = 556,500 lbs.

Necessary reduction = $\frac{1,243,500}{1,800,000}$ = 69%

ten year minimum monthly spring flow is 350 cfs, this represents 650 cfs of low flow augmentation. Table II-6 shows the required low flow augmentation for discharge in the fall with an 85 percent reduction of the present waste load from the sugar plant. Low flow augmentation for discharge in the fall would require a major increase in the present river flow amounting to more than 400 cfs in the mean year, even with 85 percent removal of the present effluent. Complete storage of beet sugar wastes during the fall campaign appears to be the only practical solution.

Based on the January phase of this survey, the effluents from the municipal treatment plants at Fargo and Moorhead are capable of causing complete deoxygenation of the river at the Grand Forks water intake during ice cover periods under certain conditions of river discharge. Chart II-6 shows zero D.O. will result at the Grand Forks water intake from municipal discharges at Fargo and Moorhead when the river discharge at Fargo is less than 170 cfs. The standard of 5.0 mg/l will be attained only when river discharge exceeds 210 cfs at Fargo. Chart II-7 illustrates the withholding of municipal wastes that will be necessary to maintain 5.0 mg/l of D.O. at the Grand Forks water intake. During January, the mean flow of the Red River at Fargo is 203 cfs. This flow is about the minimum at which the present municipal effluents may be discharged under ice cover to still maintain a standard of 5.0 mg/l at the Grand Forks water intake. At once in ten year minimum flow under ice cover (96 cfs), only 2800 lbs/day of ultimate B.O.D. or 11700 P.E. may be discharged by the municipal treatment

Table II-6

Low Flow Augmentation Required - Fall Runoff - 85% Removal Discharge from American Crystal Sugar Co. - Moorhead

Month	Necessary Flow	Expected Flow	Augmentation
(1) Once in Ten Year Low Flow			
September	660	83	577
October	400	83	317
November	200	83	117
(2) Mean Year			
September	660	240	420
October	400	200	200
November	200	190	10

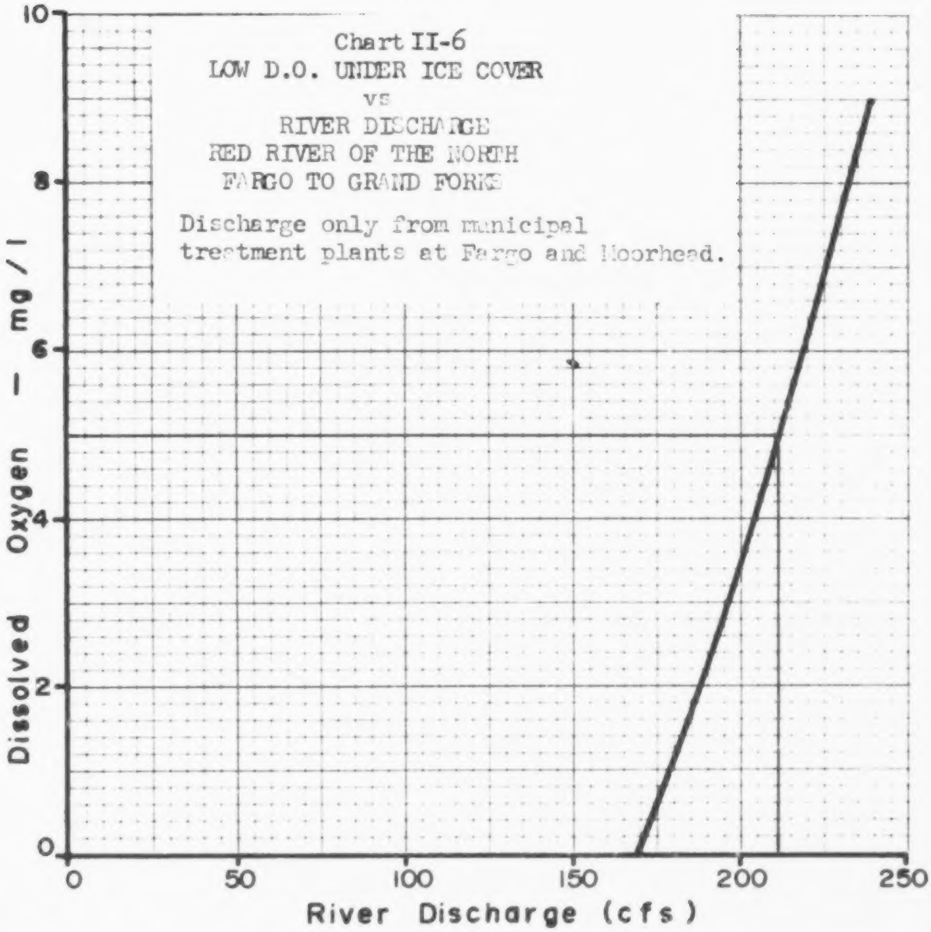


Chart II-6
LOW D.O. UNDER ICE COVER
vs
RIVER DISCHARGE
RED RIVER OF THE NORTH
FARGO TO GRAND FORKS

Discharge only from municipal treatment plants at Fargo and Moorhead.

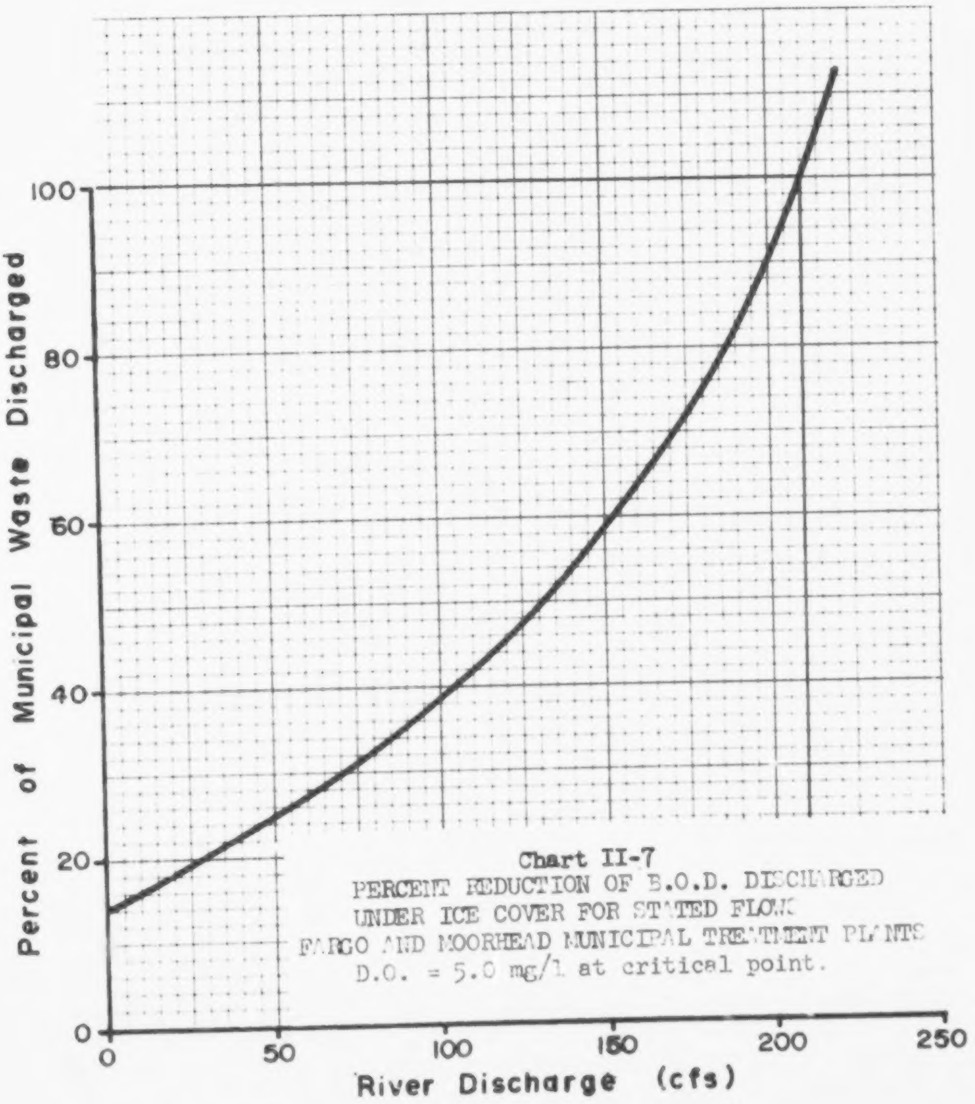


Chart II-7
PERCENT REDUCTION OF B.O.D. DISCHARGED
UNDER ICE COVER FOR STATED FLOWS
FARGO AND MOORHEAD MUNICIPAL TREATMENT PLANTS
D.O. = 5.0 mg/l at critical point.

plants, a further reduction of 63 percent. To prevent recurring depletion of D.O. at Grand Forks, as experienced in the past under ice cover, provision must be made for reducing waste discharges during periods of lower than mean flow.

In September and November, the 5-day B.O.D. after reaching an apparent low at about R.M. 403 increased downstream although there was no significant source of waste in this reach. Also, the D.O. continued to increase and supersaturation occurred downstream from R.M. 357. These values of 5-day B.O.D. are listed in Table II-7. The 5-day 20°C. B.O.D. is not the total amount of oxygen demand exerted by the oxidizable matter available for decomposition but only that amount of it which is exerted in five days. As the reaction proceeds, a plateau is reached when the oxygen demand of the organic matter has been satisfied. This plateau is a measure of the total oxygen demand of the carbonaceous organic matter present. In a heterogeneous waste, there is both carbonaceous and nitrogenous organic matter. The carbonaceous material is more readily oxidizable and stabilization of this matter proceeds first. When most of the carbonaceous material has been satisfied, the biota necessary for the oxidation of nitrogenous material became predominant and the B.O.D. exhibits a sharp rise. This is known as the second stage demand. Table II-8 shows that, at R.M. 441, where was a substantial second stage demand in the river. It lists the substantial second stage demand of the Fargo sewage treatment plant effluent and the American Crystal Sugar plant wastes. The Moorhead sewage treatment plant would

Table II-7

5-day 20°C. B.O.D.

Red River of the North

Fargo to Grand Forks

Station	River Mile	5-DAY 20°C. B.O.D.			
		Sept.		Nov.	
		mg/l	lbs/day*	mg/l	lbs/day*
RR- 9	462	3.4	1285	2.0	2550
RR-10	441	9.8	3990	15.4	19170
RR-11	436	8.5	3500	10.7	13260
RR-12	426	7.6	6100	6.3	9900
RR-14	416	6.4	6260	4.2	7260
RR-15	403	5.9	5870	4.4	7610
RR-16	386	7.0	7100	4.8	8120
RR-18	375	7.0	8210	4.4	9110
RR-19	357	8.3	10050	4.4	9020
RR-20	347	6.7	8300	4.6	9500
RR-21	335	5.8	9320	4.7	10200
RR-22	319	4.5	7850	4.8	10350
RR-23	305	3.2	5750	5.4	11630
Tributaries					
SH-13	428-1	4.8	1750	3.4	1178
WM-17	380-3	1.8	275	1.1	405

* lbs/day = mg/l x Q (cfs) x 5.4

Table II-7 (Cont.)

5-Day 20°C. B.O.D.

Red River of the North

Fargo to Grand Forks

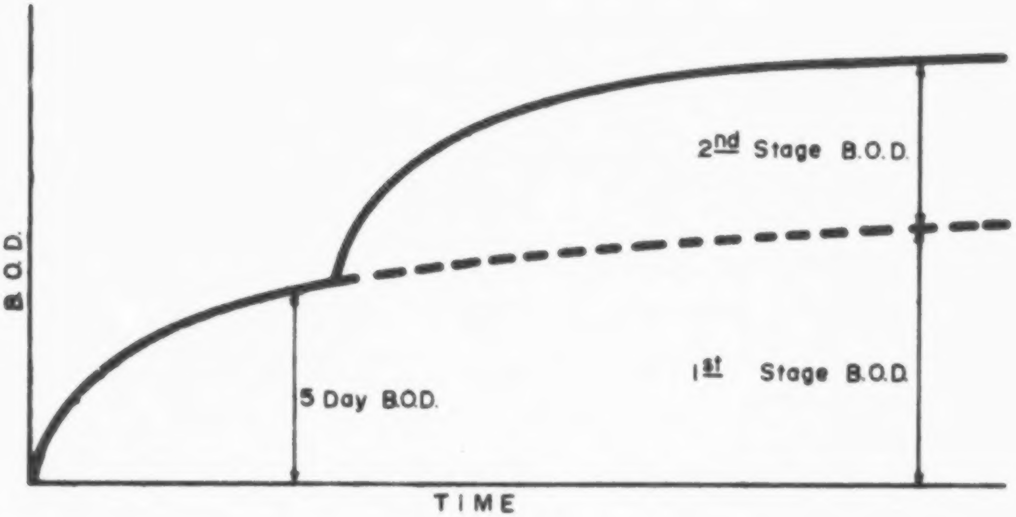
Station	River Mile	5-DAY 20°C. B.O.D. January (1) mg/1	January (1) lbs/day	January (2) mg/1	January (2) lbs/day
RR- 9	462	1.8	1840	1.8	1840
RR-10	441	13.6	14200	5.8	6050
RR-11	436	8.0	8300	4.6	4750
RR-14	416	7.1	10150	2.4	3440
RR-15	403			2.2	3150
RR-16	386	4.9	6980	2.2	3130
RR-18	375	4.8	7550	2.2	3460
RR-19	357	8.0	12600	1.8	2850
RR-20	347	7.8	12500	2.1	3380
RR-21	335	7.0	11500	1.9	3110
RR-22	319	6.3	10300	2.4	3930
RR-23	305			1.5	2450
G.F.water intake				1.4	2290

(1) Mean of values resulting from ACS - Moorhead clean-up operation.

(2) Mean of values not affected by ACS - Moorhead clean-up operation.

Table II-8

First and Second Stage B.O.D. at Fargo-Moorhead



Location	1st stage Ultimate B.O.D.		2nd stage Ultimate B.O.D.		5-day B.O.D.	
	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
R.M. 441*	19	23600	21.5	26750	17.1	21300
Effluent - American Crystal Sugar Co. Moorhead*	423	10600	207	5200	439**	11000
Effluent - Fargo Municipal Treatment Plant*	81	2710	107	3580	54	1800
Effluent - Moorhead Municipal Treatment Plant	229	3840	No data***		155	2590

* Results obtained from long term B.O.D. on grab sample.

** Second stage B.O.D. exertion had begun.

*** Moorhead treatment plant uses the same process as the Fargo plant.

also contribute a large second stage demand since it is the same type as at Fargo. This second stage B.O.D. began to exert its effect in the river downstream of R.M. 403, as was evidenced by the increase in B.O.D. during September and November. The oxidation of nitrogenous material produces nitrates. Nitrates in addition to phosphorus are a primary nutrient for the growth of algae which in the presence of sunlight, convert carbon dioxide to oxygen. There was an increase in D.O. during the day to supersaturation. Oxygen production by algae during November is shown in Table II-9. In September, the time of travel in this reach was large due to the lower flows and considerably less second stage material was available. Oxidation of second stage nitrogenous material and the production of oxygen by algae occurred in the reach between R.M. 403 and R.M. 347. Downstream of R.M. 347, the D.O. dropped from 9.9 mg/l to 6.9 mg/l at R.M. 305. This was a result of a further additional demand on the oxygen resources caused by the decomposition of the suspended algae when the supply of nutrients had been depleted. The algae growth in the reach of river was caused by the discharge of wastes from domestic and industrial sources at Fargo and Moorhead. Because nutrients discharged in the sewage and industrial wastes from Fargo and Moorhead cause excessive algae growth downstream, the maximum practical reduction of the nitrogen and phosphorus in these wastes should be accomplished.

Table II-9

Photosynthesis Analysis*

Red River of the North

Fargo to Grand Forks - November 1964

Reach	River Miles	P #D.O./day	R #D.O./day	P + R #D.O./day
RR-10 to RR-11	441 to 436	- 311	- 556	- 867
RR-11 to RR-12	436 to 426	- 42	- 937	- 979
RR-12 to RR-14	426 to 416	+ 750	- 321	+ 429
RR-14 to RR-15	416 to 403	+ 1463	- 318	+1145
RR-15 to RR-16	403 to 386	+ 1946	- 545	+1401
RR-16 to RR-18	386 to 375	+ 1967	- 977	+ 990
RR-18 to RR-19	375 to 357	+ 5314	-3188	+2126
RR-19 to RR-20	357 to 347	+ 2282	-1140	+1140
RR-20 to RR-21	347 to 335	+ 2659	-1164	+1495
RR-21 to RR-23	335 to 305	+12506	-8754	+3752

* Obtained from light and dark bottles suspended in the river.

Red Lake River - Crookston to Grand Forks

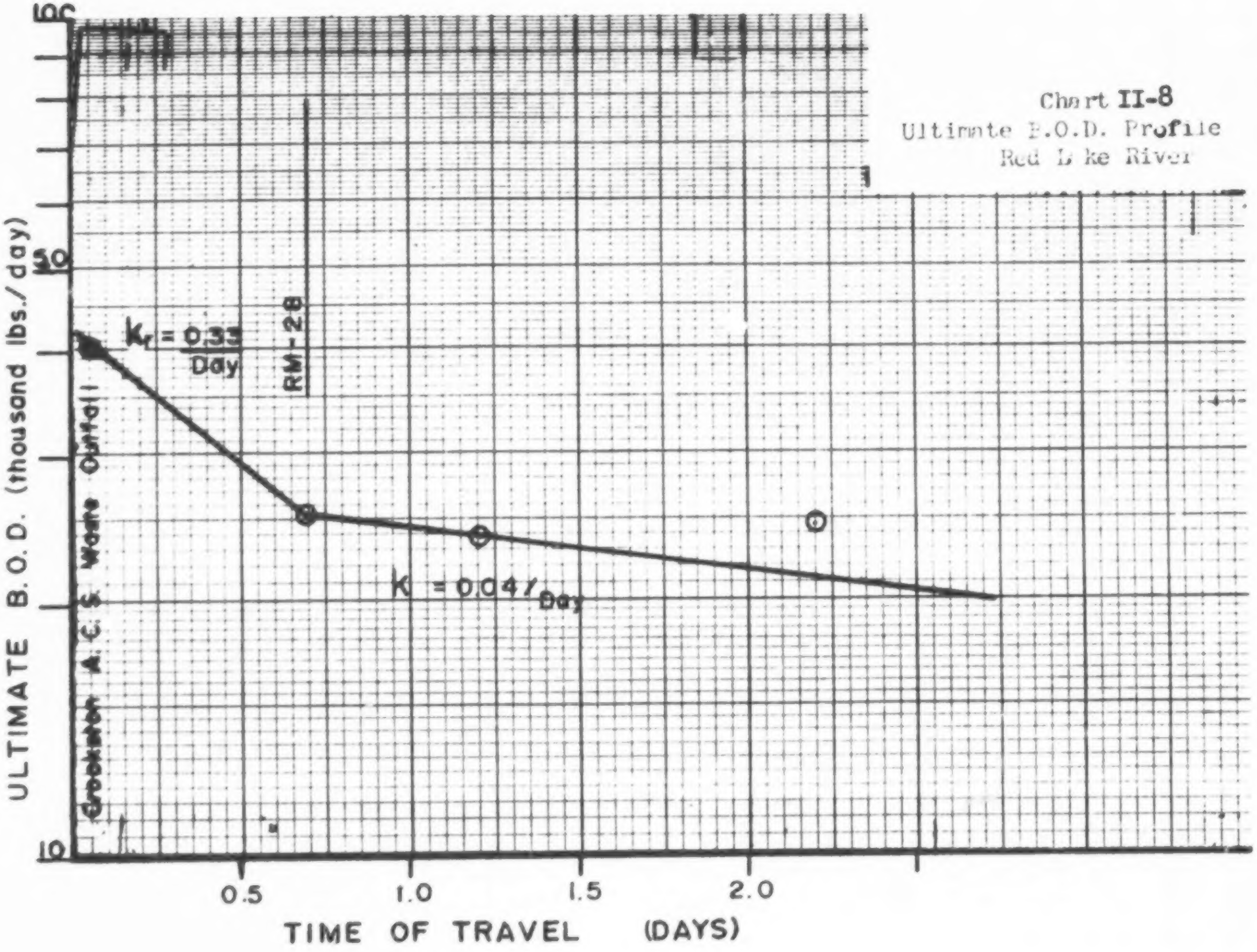
No difficulty was encountered in this stretch because of bottom deposits but the growth of biological slimes was as pronounced below the Crookston American Crystal Sugar plant as below the Moorhead plant. The same rapid rate of deoxygenation was also observed during the time the sugar plant was discharging its wastes. Due to an excessively high river discharge and the absence of bottom deposits, the severe sag observed below Fargo-Moorhead did not occur below Crookston.

Chart II-8 shows the ultimate B.O.D. profile in the river versus time of travel. The rapid initial deoxygenation was a result of the satisfaction of the highly carbonaceous beet sugar waste. The abrupt change in the river deoxygenation rate occurred when the first stage B.O.D. of the sugar waste had been oxidized. Chart II-9 shows the calculated dissolved oxygen profile through this stretch and a comparison with the observed range of values. Table II-10 lists the values used in this calculation. For the conditions experienced in November, 1964, a minimum D.O. of 10.5 mg/l was obtained.

Projection to a discharge from the sugar beet plant during September when river temperatures can be expected to average about 18°C. resulted in Chart II-10. The ultimate B.O.D. of waste discharge from the beet sugar plant is about 21,000 lbs/day. Below 330 cfs of river discharge the minimum D.O. will be less than 5.0 mg/l with this waste load. At 112 cfs, which is the once in ten year monthly low flow for September, the minimum D.O. will approach zero. Storage or treatment of the present waste effluents will be required at river

Chart II-8

Ultimate B.O.D. Profile
Red Lake River



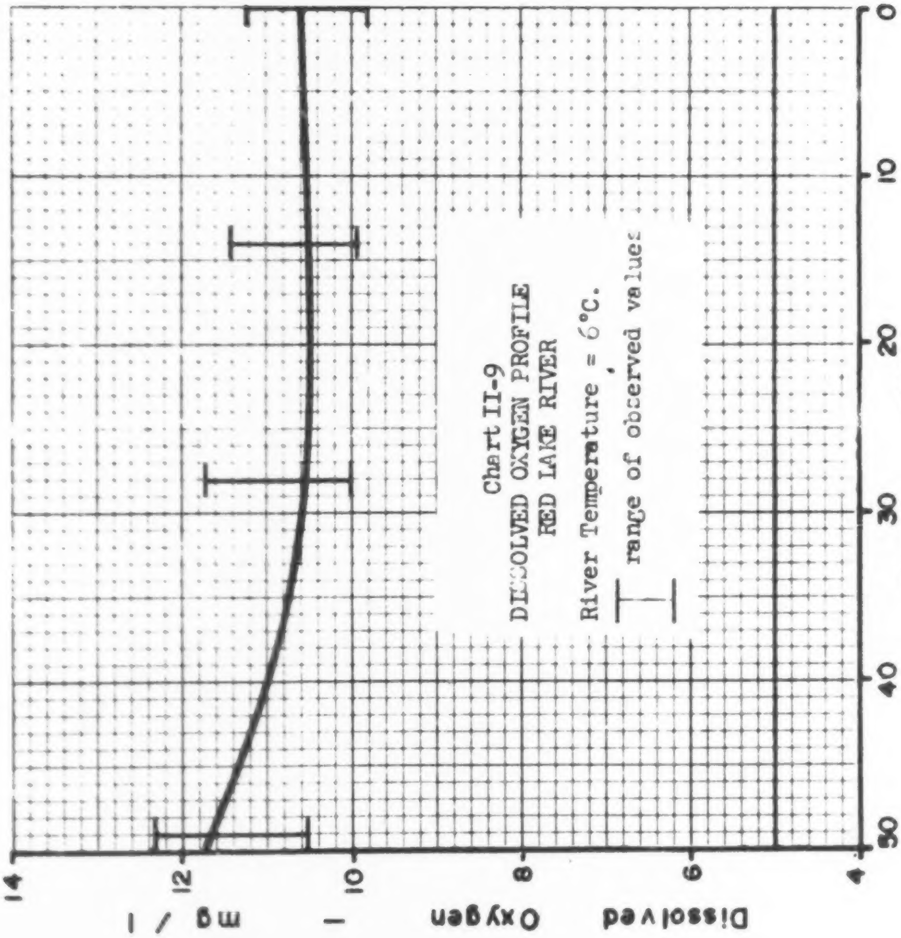


Chart II-9
DISSOLVED OXYGEN PROFILE
RED LAKE RIVER

River Temperature = 6°C.

Table II-10

Values Used in Calculation of D.O. Profile

Red Lake River - Crookston to Grand Forks

November Profile

Ultimate B.O.D. at Waste Outfalls (L_o)	42000 lbs/day
Deoxygenation Rate Constant (k_r)	
Crookston to Fisher	.33/day
Fisher to East Grand Forks	.04/day
Reaeration Rate Constant (k_2)	
Crookston to Fisher	.60/day
Fisher to East Grand Forks	.10/day
Residual Upstream Deficit of D.O. (D_o)	2650 lbs/day
River Temperature	6°C.

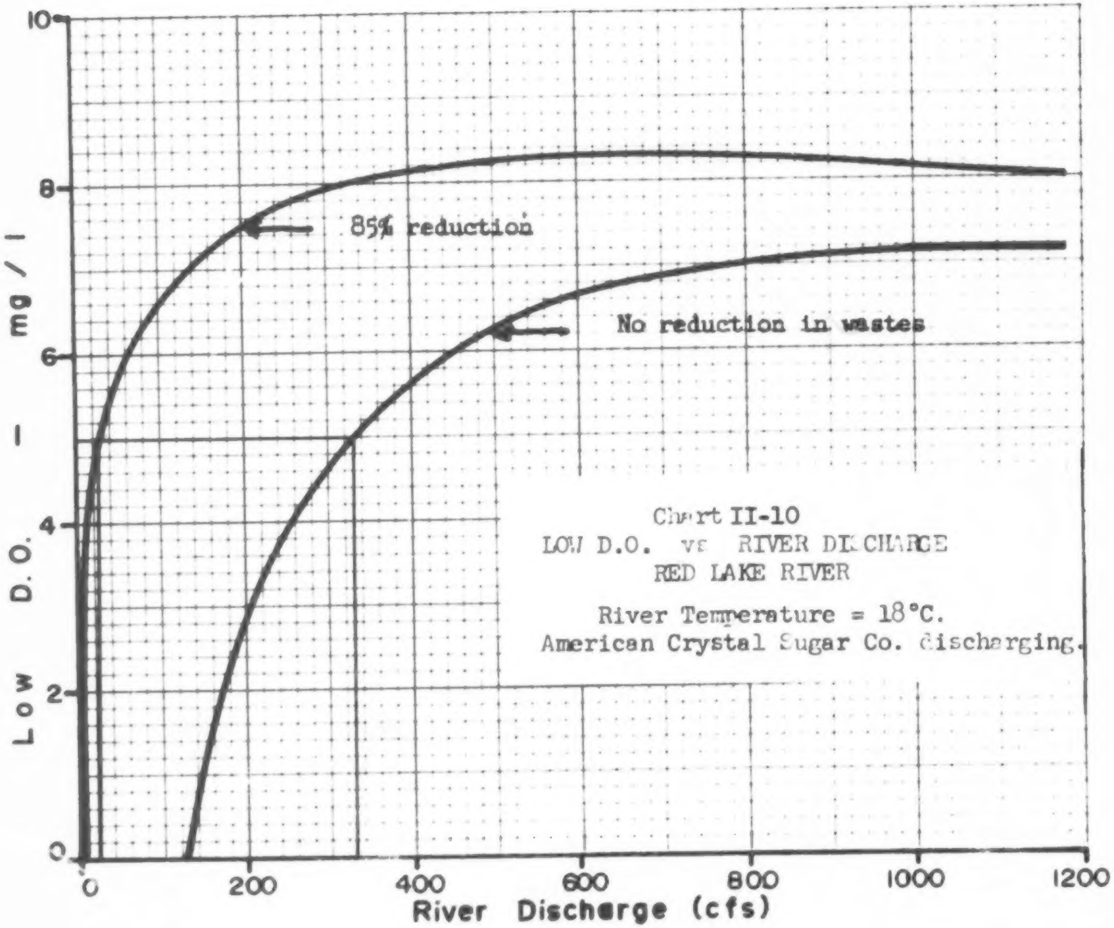


Chart II-10
LOW D.O. vs RIVER DISCHARGE
RED LAKE RIVER

River Temperature = 18°C.
American Crystal Sugar Co. discharging.

discharges less than 330 cfs to maintain 5 mg/1 of D.O. in the river. This can be expected on the average about three times in eight years.

The amount of organic matter that may be discharged to the river to maintain a minimum D.O. of 5.0 mg/1 under open water conditions is shown in Chart II-11. Some reduction in wastes will be required during the low flow years throughout the campaign period, as shown in Table II-11. Additional treatment or storage would be required during the fall campaign period about twice in five years. The flows expected in the river during the spring runoff are sufficiently high to permit discharge of the stored winter wastes in a short period after the ice breakup.

A consideration of low flow augmentation showed that supplementary stream discharges would not be necessary if there were a reduction in waste concentrations of 85 percent.

At East Grand Forks the Red Lake River had 24,500 pounds per day of ultimate B.O.D. still remaining from the waste discharge of the American Crystal Sugar Company plant at Crookston. This figure includes a substantial second stage B.O.D. which was exerted in the Red River of the North.

Red River of the North - Grand Forks to International Boundary

Below the Grand Forks metropolitan area, the dilution afforded by the confluence of the Red Lake and Red rivers mitigated the D.O. sag resulting from the waste discharges. Also, the B.O.D. of the effluent from the American Crystal Sugar plant at East Grand Forks,

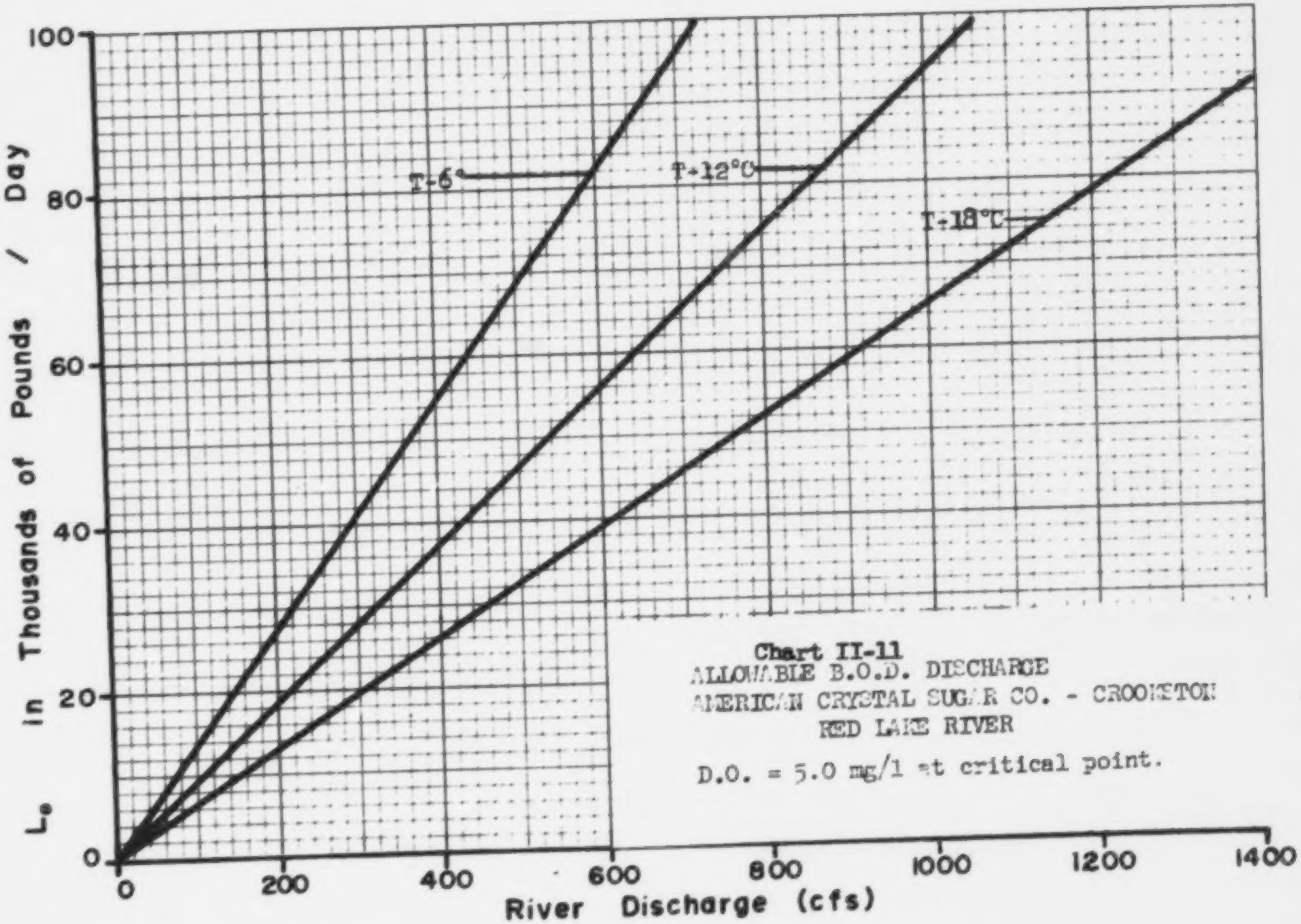


Chart II-11
ALLOWABLE B.O.D. DISCHARGE
AMERICAN CRYSTAL SUGAR CO. - CROOKSTON
RED LAKE RIVER

D.O. = 5.0 mg/1 at critical point.

Table II-11

Removal Required for Discharge in Low Flow Months

Discharge = 21,000 lbs/day

American Crystal Sugar Co. - Red Lake River

Month	Ten Year Monthly Low Flow	Ultimate B.O.D. Allowable Discharge lbs./day	Percent Removal
September	112	7,000	67 %
October	128	12,000	43 %
November	125	16,500	21 %

amounting to 9,000 lbs/day, was less than that of the other two plants and was combined in the river with the wastes from several potato processing operations and the residual pollution from the Red Lake River. This combination of significant amounts of potato wastes with the sugar waste lowered the rate of deoxygenation in the river so that use of the dissolved oxygen was slower. A small quantity of biological slimes was observed in the river below Grand Forks and these caused some acceleration in deoxygenation rate for a distance of about six miles below the sources of waste.

Chart II-12 shows the observed ultimate B.O.D. profile below the waste outfalls to R.M. 286. The remainder of the curve is the calculated profile of the first stage demand in the river obtained from the rate of first stage satisfaction at a sampling station immediately below the waste outfalls. This was necessary because the observed values were a reflection of both first and second stage demands proceeding at the same time. Table II-12 lists the observed B.O.D. in this stretch. The satisfaction of the demand produced a very slight D.O. sag in the river with a low value of 11 mg/l occurring 12 miles below the sources of wastes. The calculated values and the observed range of D.O. are shown in Chart II-13. The values used to construct this profile are listed in Table II-13.

Chart II-14 shows the effect of the wastes discharged at Grand Forks-East Grand Forks on D.O. for various conditions of river discharge at a river temperature of 18°C. For continued waste discharge, reduction in the present load would be required only for river discharges

Chart II-12
Ultimate B.O.D. Profile
Grand Forks-East Grand Forks to Oslo, Minn.

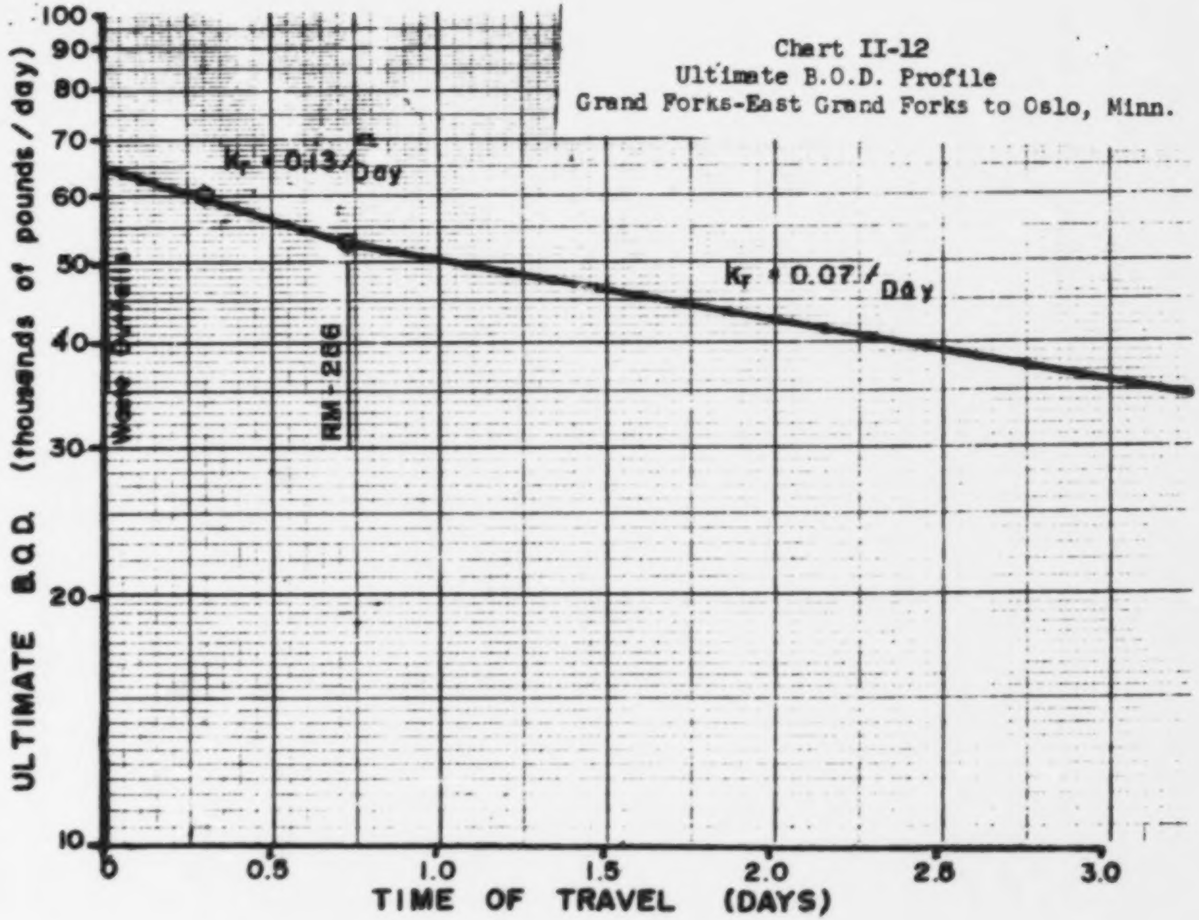


Table II-12

5-Day 20°C. B.O.D.

Red River of the North

Grand Forks to International Boundary

Station	River Mile	5-DAY 20°C. B.O.D.					
		September		November		January	
		mg/l	lbs/day*	mg/l	lbs/day*	mg/l	lbs/day*
RR-27	298	2.3	7600	3.4	28090	2.2	11350
RR-28	292	3.6	12100	6.0	49090		
RR-29	286	3.2	11250	5.2	43070		
RR-30	279	3.0	10800	4.8	39500	1.7	8700
RR-31	274	2.5	9500	4.6	38290	1.8	9150
RR-32	254	2.6	10000	4.9	41220		
RR-34	236	2.1	8500	4.4	37460	1.7	8550
RR-36	208	1.9	7950	4.2	36620	1.2	6000
RR-37	176	2.0	8550	3.7	31210		
RR-39	158	1.7	7800	3.5	28720	1.3	6400
Tributaries							
FR-33	243-7	11.2	360	9.1	540		
PR-35	222-5	20.2	870	6.0	240		
PE-38	158-0.5	1.6	1000	1.8	495		

* lbs/day = mg/l x Q (cfs) x 5.4

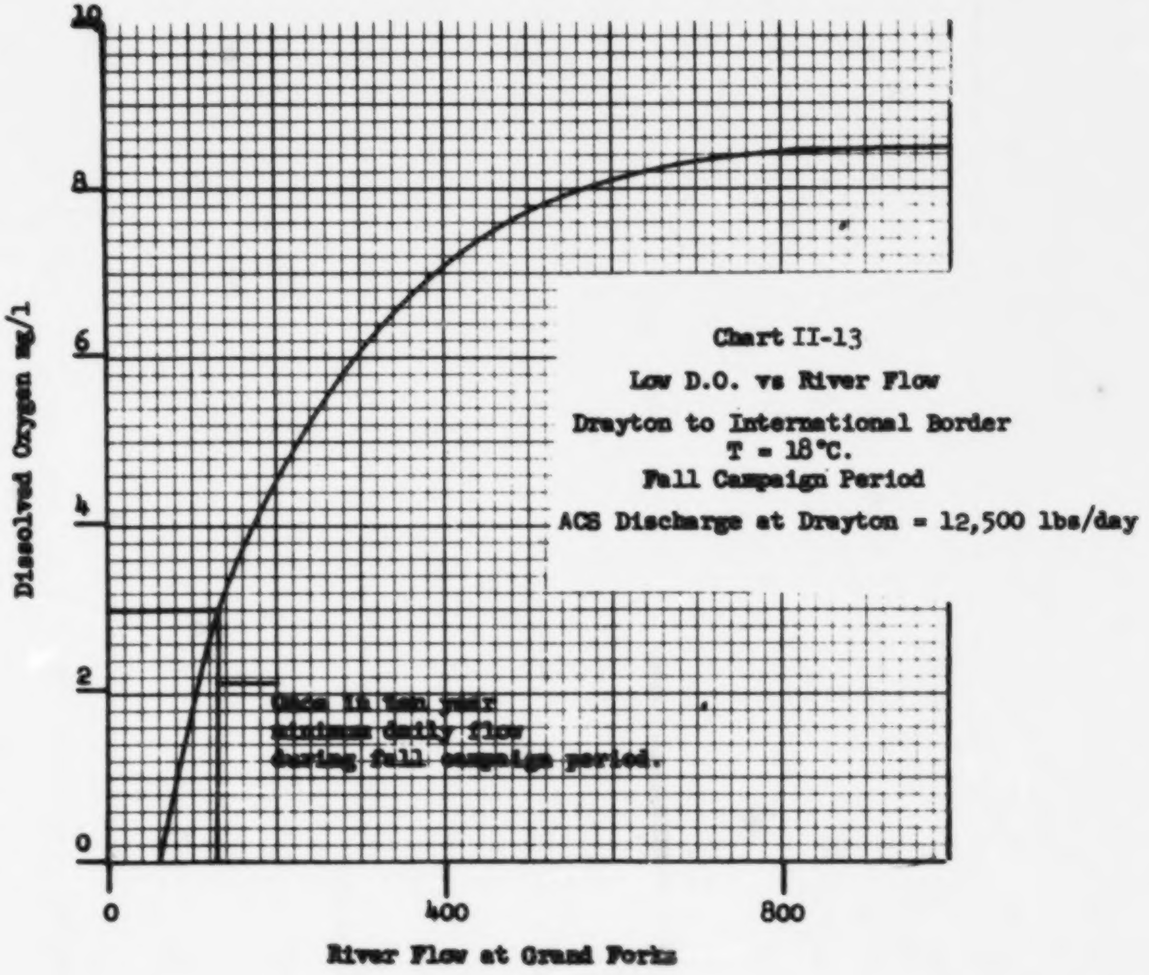


Chart II-13

Low D.O. vs River Flow

Drayton to International Border
T = 18°C.
Fall Campaign Period

ACS Discharge at Drayton = 12,500 lbs/day

Table II-13

Values Used in Calculation of D.O. Profiles

Red River of the North - Grand Forks to International Boundary

November Profile

Ultimate B.O.D. at Waste Outfalls (L_o)	65000 lbs/day
Deoxygenation Rate Constant (k_r)	
R.M. 296 to R.M. 286	.15/day
R.M. 286 to R.M. 274	.07/day
Reaeration Rate Constant (k_2)	.35/day
Residual Upstream Deficit of D.O. (D_o)	1900 lbs/day
River Temperature	6°C.

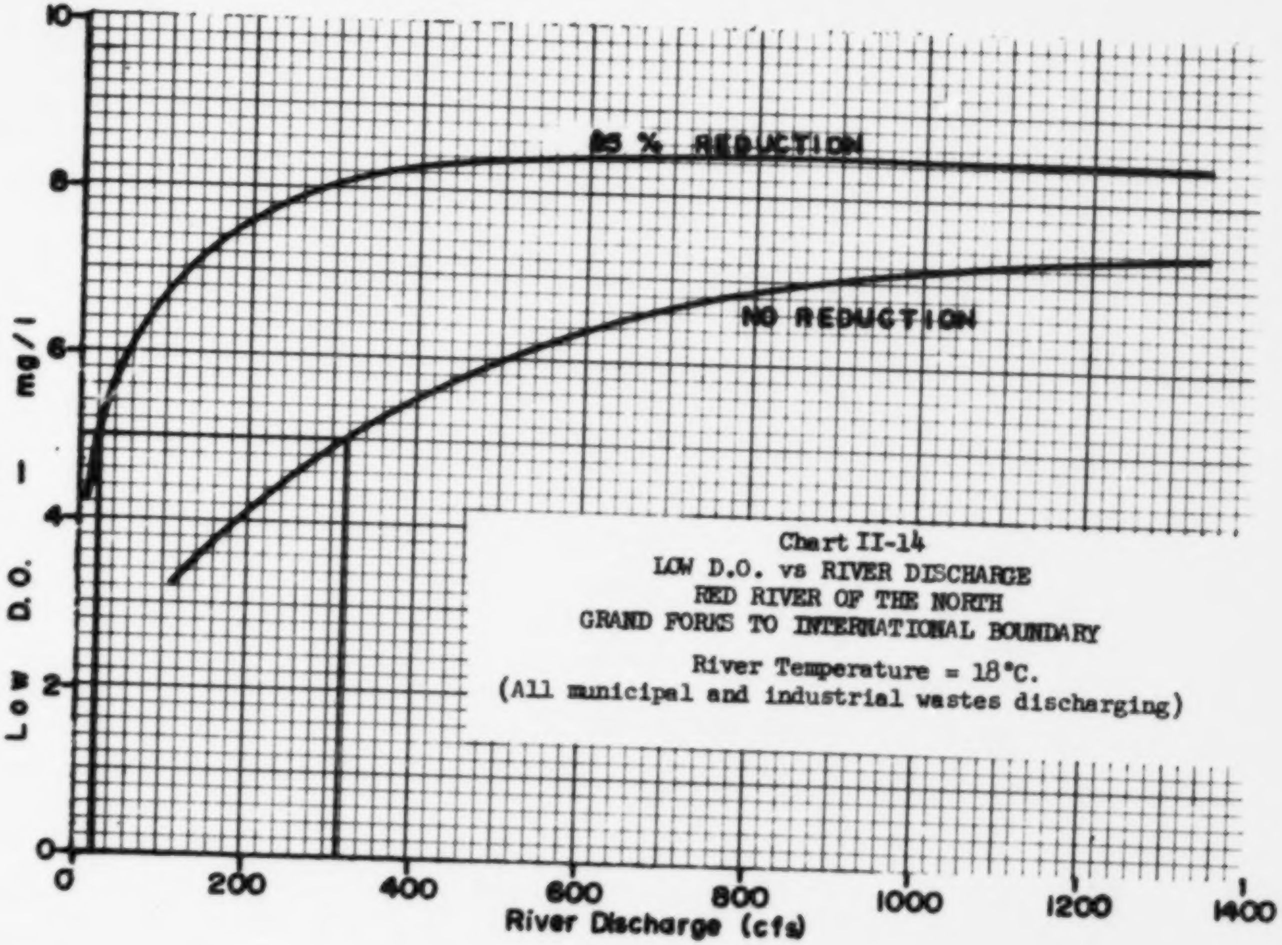


Chart II-14
LOW D.O. vs RIVER DISCHARGE
RED RIVER OF THE NORTH
GRAND FORKS TO INTERNATIONAL BOUNDARY

River Temperature = 18°C.
(All municipal and industrial wastes discharging)

less than 300 cfs during open water periods to maintain a standard of 5.0 mg/l. Since the once in ten year low flow during the beet sugar campaign is greater than 300 cfs, no storage of beet wastes would be required during the fall period of the campaign to maintain D.O. levels if the potato wastes are removed and treated in the Grand Forks municipal system. This conclusion is reinforced by ChartII-15 which shows that even with warm river temperature (18°C.), all of the present quantity of wastes may be discharged.

The river recovers from the pollution discharged in the Grand Forks area before reaching the location of the proposed American Crystal Sugar plant at Drayton. The river also will recover from the discharge of the Drayton sugar plant before the International Boundary is reached. A D.O. of 5.0 mg/l can be maintained for an assumed discharge of 24000 pounds from the plant at river flows greater than 420 cfs and 18°C. river temperature. The assumed discharge is based on 4.0 pounds per day of B.O.D. per ton of beets processed. Since the once in ten year low flow during the beet sugar campaign is greater than 420 cfs, the flow below which storage or treatment must be provided, it is anticipated that no storage will be required during the fall period of the campaign to maintain adequate D.O. levels below Drayton. However, if slime growths develop and accelerate the rate of deoxygenation and if the discharge creates a significant benthal demand and destroys bottom organisms, detention will be required. Complete withholding during the period of ice cover will be necessary

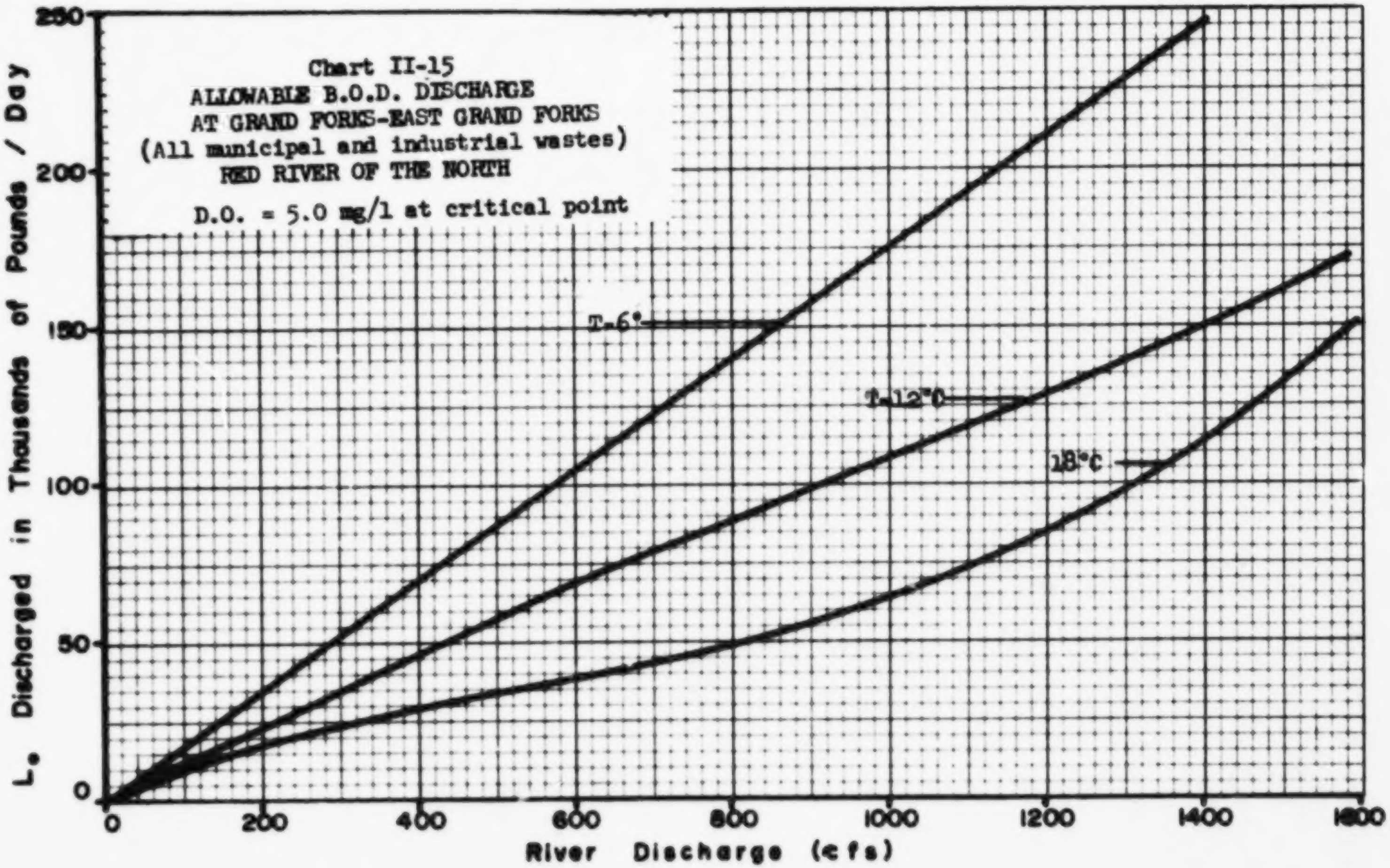


Chart II-15
ALLOWABLE B.O.D. DISCHARGE
AT GRAND FORKS-EAST GRAND FORKS
(All municipal and industrial wastes)
RED RIVER OF THE NORTH

D.O. = 5.0 mg/l at critical point

APPENDIX III

WATER POLLUTION CONTROL

Laws and Regulation

State Statutes

40-2204 (Amended 1953). Discharge of Sewage; Regulations Governning. Any municipality, after securing the approval of the state water commission and the state department of health as required by section 61-0221, may empty or discharge its sewage into any river, lake, coulee, or slough, employing such methods as may be required by the rules and regulations established by the state water commission and the state department of health for the prevention of pollution.

61-0221 (Amended 1953). Sewage and Waste Disposal or Discharge; Water Supply Plant; Approval of Commission Required. No plant or facility for the disposal or discharge of municipal or industrial sewage or waste substances or works for the water supply of any municipality shall be constructed without the prior approval of the commission, which shall be granted only upon the approval of the state department of health. No such plant, facility, or works shall be operated or maintained except in accordance with the rules and regulations established by the commission for the prevention of water pollution.

61-01-04 (Amended 1965). Fouling Public Water; What Included. The provisions of section 61-0113 shall be construed to include:

1. Privies and privy vaults;

2. Any stable, shed, pen, yard, or corral wherein is kept any horse, bovine, sheep, or swine and located nearer than sixty feet from the top of the bank of such lake or stream; and

3. Any slaughterhouse, grave, graveyard, or cemetery located nearer than eighty feet from any lake or stream.

The provisions of this section shall not be construed to prevent any city within this state from discharging untreated sewage or waste into any river temporarily on an emergency basis, provided that such discharges are determined by the state department of health not to be detrimental to public health and safety. The provisions of this section shall not be construed to prevent any city within this state from discharging untreated sewage or waste into any river prior to July 1, 1967.

61-02-04, Subsection 2 (Amended 1965).

2. To define, declare, and establish rules and regulations;

   a. For the sale of waters and water rights to individuals, associations, corporations, municipalities, and other political subdivisions of the state, and for the delivery of water to users;

b. For the full and complete supervision, regulation, and control of the water supplies within the state;

c. For the complete supervision and control of acts tending to pollute watercourses, for the protection of the health and safety of all the people of the state; and to pollute shall mean such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquefied, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life; and

d. Establish rules and regulations governing and providing for financing by local participants to the maximum extent deemed practical and equitable in any water development project in which the state participates in cooperation with the United States or with political subdivisions or local entities.

State Department of Health Regulation

Regulation 61.

Section 1. Sanitary Regulation No. 1 of the State Water Conservation Commission follows and is hereby declared to be a part of the Regulations of the State Department of Health:

"No system for the disposal of sewage, industrial waste, garbage, or refuse, tending to pollute watercourses, shall be installed by any public agency or by any person or corporation, nor shall any such existing system by materially altered or extended until satisfactory plans and specifications for the installation, alteration, or extension, together with such information as the State Water Conservation Commission and the State Department of Health may require, have been submitted in duplicate and approved by the State Water Conservation Commission and the State Department of Health, and no construction shall take place except in accordance with the approved plans."

Section 2. Whenever complaint shall be made to the State Department of Health of the pollution or of the polluted condition of any of the waters of the state, or whenever the State Department of Health shall have reason to believe that any of the waters are being polluted in a manner prejudicial to the health and comfort of any of its inhabitants, it shall be the duty of the State Department of Health to make an investigation covering the pollution or the polluted condition. Whenever an investigation shall be undertaken by the State Department of Health, it shall be the duty of any organization or person concerned in such pollution to furnish upon request to the State Department of Health, such information as may be required as to the amount and character of the polluting material discharged into the said waters by such organization or person. The State Health Officer, or his representative, shall have the right of entry, during any operating period, to all buildings and property of any organization or person, for the purpose of investigating the character and amount of polluting materials being discharged. If the State Department of Health shall find that any of the waters of the state have been or are being polluted in a manner prejudicial to the health and comfort of its inhabitants, the State Department of Health shall have the authority to make an order requiring such pollution to cease within a reasonable time, or requiring such manner of treatment or of disposition of the sewage or other polluting material as may in its judgment be necessary to prevent the future pollution of such waters, or both. And it shall be the duty of the organization or person to whom such order is directed to fully comply with the said order of the State Department of Health. If the organization or person shall consider the requirements of the said order to be illegal, unjust, or unreasonable, an appeal therefrom within 30 days after the making of the order can be made to the district court of the county in which the pollution or polluted condition occurs; and the said court shall hear the said case without delay, and shall render a decision approving, setting aside or modifying the said order, or fixing the terms upon which said permit shall be granted, and stating the reasons therefor.

"Sewage" is a combination of the liquid wastes conducted away from residences, business buildings, and institutions, together with those from industrial establishments; and with such ground, surface and storm water as may be present.

By the term "organization" in this regulation is meant municipality, company, corporation, or institution.

STANDARDS OF TREATMENT FOR MUNICIPAL AND INDUSTRIAL WASTES FOR THE RED RIVER OF THE NORTH

The following previously adopted standards on stream pollution control are hereby confirmed and clarified, and recommended for use under ordinary conditions as a basis for the review of plans prepared and submitted to the regulatory agencies of the respective states for sewage and waste treatment facilities discharging into the Red River of the North and the tributaries as they affect the Red River of the North.

It is recommended that industry and municipalities treat their wastes to the point where the average daily composite 20° C., 5-day B.O.D., is 25 P.P.M., suspended solids 30 P.P.M., with no peaks running over 50 P.P.M., 20° C., 5-day B.O.D. and 60 P.P.M. suspended solids. Chlorination shall not be used as a means of obtaining these B.O.D. reductions, although it may be required for other purposes. Certain types of industrial wastes such as those resulting from the processing of agricultural products, may have to be considered on an entirely different basis.

It is further recommended that these standards be considered as general only, and that they be subject to modification to meet specific pollutional problems as they develop.

WATER POLLUTION CONTROL
RED RIVER BASIN
NORTH DAKOTA
September 1, 1965

CITY & POPULATION	YEAR CONSTR.	TYPE OF TREATMENT	MONEYS SPENT SINCE JAN. 1, 1957 ON WASTE TREATMENT FACILITIES
MAIN STEM:			
Abercrombie 244	1936	Septic Tanks	
Drayton 940	1965	Lagoon	$ 90,060.
Fairmount 503	1922	No Treatment	
Fargo 46,662	1935-61	Set., T.F., Sl. Dig., Fin. Set.	1,399,970.
Grand Forks 34,451	1961	Lagoon	2,770,870.[1]
Pembina 625	1958	Lagoon	76,490.
Wahpeton 5,876	1958	Lagoon	343,450.[1]
		Total	$4,680,840.
WILD RICE RIVER:			
Forman 530	1947	Imhoff	
Gwinner 242	1959	Lagoon	$ 17,610.
Hankinson 1,285	1959	Lagoon	45,460.
Lidgerwood 1,081	1959	Lagoon	49,500.
Milnor 658	1948	Imhoff	
Mooreton 164	1957	Lagoon	6,630.
Rutland 308	1961	Lagoon	26,600.
Wyndmere 644	1961	Lagoon	39,000.
		Total	$ 184,800.
SHEYENNE RIVER:			
Amenia 117	1935	Septic Tank	
Anamoose 503	1960	Lagoon	$ 32,900.
Arthur 325	1960	Lagoon	33,070.
Balta 165	1961	Lagoon	22,330.
Binford 261	1962	Lagoon	31,460.
Casselton 1,394	1959	Lagoon	73,540.
Cooperstown 1,424	1961	Lagoon	32,760.
Enderlin 1,596	1959	Lagoon	41,890.
Esmond 420	1956	Lagoon	
Hannaford 277	1958	Lagoon	50,610.
Harvey 2,365		Contracts Let	54,000.[2]
Hope 390	1950	Lagoon	
Kathryn 142	1961	Lagoon	28,840.

CITY & POPULATION	YEAR CONSTR.	TYPE OF TREATMENT	MONEYS SPENT SINCE JAN. 1, 1957 ON WASTE TREATMENT FACILITIES
Kindred 580	1949	Primary and T.F.	
Leonard 232		Lagoon under construction	$ 31,900.[3]
Lisbon 2,093	1936	Primary and T.F.	
Litchville 345	1959	Lagoon	26,870.
McVille 551	1920	Septic Tank	
Maddock 740	1949	Lagoon	
Page 432	1962	Lagoon	41,710.
Pekin 180	1962	Lagoon	28,490.
Sheyenne 423	1959	Lagoon	30,940.
Southwest Fargo 3,328	1958	Lagoon	359,960.[1]
Tolna 291	1959	Lagoon	28,170.
Tower City 300	1960	Lagoon	14,770.
Valley City 7,809	1961	Lagoon	152,800.
West Fargo 93	1964	Primary and T.F.	153,980.
Wimbledon 402	1927	Septic Tank	
		Total	$1,270,990.
MAPLE RIVER:			
Buffalo 234	1965	Lagoon under construction	$ 38,760.[3]
Mapleton 180	1965	Lagoon under construction	26,000.[3]
		Total	$ 64,760.
ELM RIVER:			
Grandin 147	1965	Lagoon under construction	$ 34,520.[3]
Hunter 446	1959	Lagoon	44,630.
		Total	$ 79,150.
GOOSE RIVER:			
Aneta 451	1959	Lagoon	$ 40,900.
Finley 808	1963	Lagoon	42,870.
Hatton 856	1949	Imhoff	

CITY & POPULATION	YEAR CONSTR.	TYPE OF TREATMENT		MONEYS SPENT SINCE JAN. 1, 1957 ON WASTE TREATMENT FACILITIES
Hillsboro 1,278	1958	Lagoon		$ 72,070.
Mayville 2,168	1927	Imhoff		
Northwood 1,195	1953	Lagoon		36,900.[1]
Portland 606	1951	Lagoon		
Sharon 251	1963	Lagoon		60,150.
			Total	$ 252,890.
TURTLE RIVER:				
Emerado 328	1962	Lagoon		$ 45,720.[1]
Grand Forks Air Base 3,000 Est.	1955	Lagoon		
Larimore 1,714	1952	Lagoon		41,460.[1]
Petersburg 272	1957	Lagoon		32,700.
			Total	$ 119,880.
FOREST RIVER:				
Fairdale 126	1958	Lagoon		$ 26,760.
Fordville 367	1955	Lagoon		
Minto 642	1953	Lagoon		
			Total	$ 26,760.
PARK RIVER:				
Adams 360	1956	Lagoon		
Crystal 372	1958	Lagoon		$ 32,060.
Edinburg 330	1956	Lagoon		
Grafton 5,885	1959	Lagoon		481,610.[1]
Hoople 334	1958	Lagoon		36,980.
Milton 264	1961	Lagoon		44,110.
Osnabrock 289	1958	Lagoon		28,720.
Park River 1,813	1955	Lagoon		55,070.[1]
St. Thomas 660	1959	Lagoon		48,490.
			Total	$ 727,040.
PEMBINA RIVER:				
Cavalier 1,423	1955	Lagoon		$ 16,070.[1]

CITY & POPULATION	YEAR CONSTR.	TYPE OF TREATMENT	MONEYS SPENT SINCE JAN. 1, 1957 ON WASTE TREATMENT FACILITIES
Langdon 2,151	1959	Lagoon	$ 33,410.
Neche 545	1956	Lagoon	9,050.[1]
Walhalla 1,432	1940	No Treatment	
		Total	$ 58,530.
	Total Moneys Spent in Basin		$7,465,740.

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1. Includes moneys spent for interceptor sewers, lift stations, etc., to bring wastes to treatment plant rather than discharge untreated to streams.

2. Contracts awarded for beginning construction of treatment facilities this fall.

3. Treatment facilities presently under construction.

POPULATION SERVED:	Main Stem	89,301
	Wild Rice	4,912
	Sheyenne	27,178
	Maple	414
	Elm	593
	Goose	7,613
	Turtle	5,314
	Forest	1,135
	Park	10,307
	Pembina	5,551
	Total	152,218

APPENDIX IV

Exhibit 1

EXCERPT OF MINUTES OF REGULAR WATER POLLUTION CONTROL COMMISSION MEETING

July 9, 1945

The Chairman reviewed briefly the situation with respect to the disposal of sewage and industrial wastes into the Red River of the North at East Grand Forks, Minnesota, and Grand Forks, North Dakota, and pointed out that the effects of the pollution had at times extended to the international boundary and into Canada, and Mr. Whittaker reviewed the progress previously made in the investigation of water pollution conditions in the Red River of the North, under cooperative arrangements between the interested agencies of the states of North Dakota, South Dakota and Minnesota, and read the agreement adopted by these agencies, creating the Red River Drainage Basin Interstate Sanitation Committee, dated May 15, 1944, of which he had been selected to act as temporary chairman; also the resolution relative to the Red River and its tributaries later adopted by the Committee, setting forth certain general standards and recommendations relating to the discharge of sewage and wastes into the Red River of the North.

Mr. Scott made a motion that Mr. Whittaker be instructed to take the matter up with the Interstate Sanitation Committee for study and recommendation, and to advise the City Attorney (of East Grand Forks) of such action. Motion seconded by Dr. West. Put to vote, and carried.

Dr. West moved that the Commission approve the Interstate Sanitation Committee agreement and the resolution adopted by the Committee, and join with participating agencies in further activities of that Committee, and that H. A. Whittaker, Director of the Division of Sanitation, be authorized to act as a representative of the Commission on the Interstate Committee. Motion seconded by Mr. Scott. Put to vote, and carried.

EXCERPT OF MINUTES OF REGULAR WATER POLLUTION CONTROL COMMISSION MEETING

August 5, 1949

Dr. Chesley moved that the following resolution be adopted:

"RESOLVED, That the Water Pollution Control Commission declare the following policy regarding water pollution control in the Red River of the North and tributaries, and adopt the following general standards for the treatment of municipal sewage and industrial wastes discharged into the Red River of the North, as recommended by the Red River Drainage Basin Interstate Sanitation Committee:

That industry and municipalities treat their wastes to the point where the average daily composite 20° C., 5-day B.O.D., is 25 P.P.M., suspended solids 30 P.P.M., with no peaks running over 50 P.P.M., 20°C, 5-day B.O.D. and 60 P.P.M. suspended solids. Chlorination shall not be used as a means of obtaining these B.O.D. reductions, although it may be required for other purposes. Certain types of industrial wastes such as those resulting from the processing of agricultural products, may have to be considered on an entirely different basis.

and be it futher

RESOLVED, That these standards be considered as general only, and that they be subject to modification to meet specific pollutional problems as they develop, and be it further

RESOLVED, That this declaration of policy is without prejudice to any action already taken by the Commission in specific cases, or to the exercise of the authority of the Commission in any manner that may be required in the future under the circumstances of specific cases to assure adequate control of pollution in accordance with legal requirements and in furtherance of the public welfare."

Motion seconded by Mr. Scott. Carried.

Exhibit 2

WATER POLLUTION CONTROL COMMISSION
OF THE STATE OF MINNESOTA

RESOLUTION

At a special meeting of the WATER POLLUTION CONTROL COMMISSION of the State of Minnesota held in the offices of the Minnesota Department of Health at Minneapolis, at 2:00 PM on September 18, 1947, attended by the following members:

Chester S. Wilson (Chairman)	George C. Scott
Dr. Ralph L. West	A. J. Chesley, M.D. (Secretary)
Mr. R. A. Trovatten	

a quorum being present, and Chester S. Wilson presiding, Mr. Trovatten offered the following resolution and moved its adoption:

WHEREAS, the Congress of the United States by the Flood Control Act approved 22 December 1944 authorized the Red Lake-Clearwater River Flood Control Project substantially in accordance with the recommendations of the Chief of Engineers as set forth in House Document No. 345, 78th Congress, 1st Session, and

WHEREAS, said project is authorized subject to conditions that responsible local interests assure the Secretary of War that they will:

1. Without cost to the United States, provide all flowage easements and rights-of-way;

2. Hold and save the United States free from damages due to construction works and operation;

3. Make a cash contribution of $33,220 in lieu of altering bridges;

4. Take over the maintenance and subsequent replacement of all bridges improved by the United States;

5. Maintain the improved river channels;

6. Control the contamination of Red Lake, Clearwater and Thief Rivers by rural areas and villages without sewer systems;

7. Require that municipalities which discharge sewage into

Red Lake, Clearwater or Thief Rivers treat their sewage before discharge into the streams so as to effect a reduction in the biochemical oxygen demand of not less than 85 per cent for towns of 1,000 population or greater; and of 35 per cent for municipalities having a population less than 1,000.

8. Prevent the construction of any new dams or the raising of any existing dams in Red Lake, Clearwater, or Thief Rivers downstream from Lower Red Lake, Clearwater Lake, or Mud Lake, unless authorized by the War Department.

and

WHEREAS, the Red Lake Drainage and Conservancy District, duly organized under and pursuant to the laws of the State of Minnesota, has furnished its assurances to the Secretary of War by which said Drainage and Conservancy District undertakes and agrees to furnish and comply with local cooperation conditions Nos. 1, 2, 3, 4, 5 and 8, and has undertaken and agreed to comply with conditions Nos. 6 and 7 above set forth so far as law permits, and

WHEREAS, said Red Lake Drainage and Conservancy District is not charged with the responsibility for, and has no power under existing law to control the contamination of the Red Lake, Clearwater and Thief Rivers, or the discharge by cities thereon of sewage into said rivers and therefore has requested the Water Pollution Control Commission of the State of Minnesota to give and furnish its assurance to the Secretary of War that said local cooperation conditions Nos. 6 and 7 will be fully complied with, and

WHEREAS, pursuant to the provisions of Chapter 395 of the Laws of Minnesota for 1945, there is created a Water Pollution Control Commission for the State of Minnesota, which Commission has authority to control pollution of any waters of the State of Minnesota and to control the disposal of sewage, industrial waste and other wastes, and which Commission is specifically given authority and charged with the following powers and duties:

1. To administer and enforce all laws relating to the pollution of any waters of the state;

2. To investigate the extent, character, and effect of the pollution of the waters of this state and to gather data and information necessary or desirable in the administration or enforcement of pollution laws, and to make such classification of the waters of the state as it may deem advisable;

3. To establish and alter such reasonable pollution standards for any waters of the state in relation to the public use to which they are or may be put as it shall deem necessary for the purposes of said act;

4. To make and alter reasonable orders requiring the discontinuance of the discharge of sewage, industrial waste or other wastes into any waters of the state resulting in pollution in excess of the applicable pollution standard;

and

WHEREAS, in order that all of the required elements of local cooperation will be fully met and complied with by local interests, the Water Pollution Control Commission of the State of Minnesota desires to assure the Secretary of War that it will fully comply with the provisions and requirements of local cooperation conditions Nos. 6 and 7 hereinabove set forth, and to that end hereby adopts the following resolution:

NOW THEREFORE, IT IS HEREBY RESOLVED by the Water Pollution Control Commission of the State of Minnesota that said Commission does hereby undertake, agree and assure the Secretary of War that it will:

1. Control the contamination of Red Lake, Clearwater and Thief Rivers by rural areas and villages without sewer systems;

2. Require that municipalities which discharge sewage into Red Lake, Clearwater or Thief Rivers treat their sewage before discharge into the streams so as to effect a reduction in the biochemical oxygen demand of not less than 85 per cent for towns of 1,000 population or greater; and of 35 per cent for municipalities having a population less than 1,000.

AND BE IT FURTHER RESOLVED that the Secretary of this Commission be and he is hereby instructed to furnish certified copies of this Resolution to the District Engineer, War Department, Corps of Engineers, St. Paul, Minnesota, for submission as such assurances to the Secretary of War.

The Motion for adoption of said Resolution was duly seconded, presented and carried by a unanimous vote of the members present, whereupon the Chairman declared said Resolution adopted.

Attest:

S Chester A. Wilson
Commission Chairman

S A. J. Chesley, M.D.
Secretary

Exhibit 3

Excerpt of Minutes of Regular Water Pollution Control Commission Meeting
July 28, 1948

Dr. Chesley submitted a copy of the Missouri River Basin Sanitation Agreement executed by himself as Secretary and Executive Officer of the Minnesota State Board of Health, and by the corresponding authorities of the states of Colorado, Iowa, Kansas, Missouri, Nebraska, Montana, North Dakota, South Dakota, and Wyoming, comprising all the states which embrace any part of the watershed of the Missouri River. This agreement provides for the establishment of a permanent Missouri River Basin health council composed of the health officer and sanitary engineer from each of the respective states to cooperate with the U.S. Public Health Service and other agencies involved in carrying out a policy for the protection and improvement of the waters of this Basin, the prevention or correction of undue pollution thereof, and the promotion of specific health programs relating thereto.

Mr. Scott moved that the Commission endorse the agreement and pledge cooperation in carrying out the provisions thereof so far as appropriate. Motion seconded by Dr. Chesley. Carried.

MISSOURI RIVER BASIN SANITATION AGREEMENT

Whereas the Missouri River Basin is entering a phase of development of its natural resources that is of paramount importance to the states, communities and industries located in the Basin from the standpoint of health, water supply, industrial waste disposal, sewage disposal, recreation, irrigation, power and flood control; and

Whereas the benefits of any development program require full cognizance of the many public health problems; and

Whereas the control of pollution and proper restriction on waste usage is essential to the full development of the aforesaid Missouri River Basin; and

Whereas the Missouri River and many of its tributary streams are interstate waters and streams common to the states of Montana, Minnesota, Wyoming, North Dakota, South Dakota, Colorado, Nebraska, Kansas, Iowa and Missouri, and the misuse of water originating in one state does or may prejudicially affect public water supplies, public health, or public interest in a neighboring state or states, thus creating a problem of common interest and requiring cooperation between the several states:

THEREFORE BE IT RESOLVED that the Departments of Health of the States of Montana, Wyoming, North Dakota, South Dakota, Colorado, Nebraska, Kansas, Minnesota, Iowa and Missouri, represented by the executive officers of the said Departments of Health do hereby agree to establish a permanent Missouri River Basin Health Council, composed of the health officer and the sanitary engineer from each of the respective states; and further agree to cooperate with the United States Public Health Service and other agencies involved in carrying out a policy for the protection and improvement of the waters of this Basin wherever necessary in these states, and the prevention or correction of undue pollution thereof, and in the promotion of specific health programs relating thereto; to the end that full development of the said Basin with its many benefits may be realized by all the people residing in the area.

(s)____________________
R. L. Cleere, M.D.
Secretary and Executive Officer
Colorado State Department of Public Health

(s)____________________
Walter L. Bierring, M.D.
State Health Commissioner,
Iowa State Dept. of Public Health

(s)____________________
F. C. Beelman, M.D.
Secretary and Executive Officer,
Kansas State Board of Health

(s)____________________
A. J. Chesley, M.D.
Secretary and Executive Officer
Minnesota State Board of Health

(s)__________________________
R. J. James, M.D.
Director Division of Health,
Missouri

(s)__________________________
W. S. Petty, M.D.
State Health Officer of Nebraska

(s)__________________________
Russell O. Saxvik, M.D.
State Health Officer, North Dakota
State Health Department

(s)__________________________
Gilbert Cottam, M.D.
Superintendent, South Dakota State
Board of Health

(s)__________________________
G. M. Anderson, M.D.
State Health Officer, Wyoming
State Department of Health

(s)__________________________
Burton K. Kilbourne, M.D.
Secretary Montana State Board of
Health

WATER QUALITY OBJECTIVES

Present water uses, increased usability due to improved water quality, and protection of water rights and property values largely determine pollution control measures needed. The goal of water pollution control programs is to preserve water quality to best serve these interests.

The Engineering Section of the Missouri Basin Health Council, consisting of the chief sanitary engineers of the 10 Basin States, adopted on February 27, 1952, objectives* as a guide for water pollution control programs in the Basin. The tentative guide has been employed by the States in the development of their comprehensive program as presented in this report. It is recognized by the States that changes in conditions, particularly as they may affect water uses, and alterations in types of water uses, may require future moderations in any established standards. The tentative objectives as adopted by the States of the Basin are quoted as follows:

> "Subject to (a) such higher objectives as may be desired by any State and (b) such other modification as may be deemed necessary, after appropriate investigation, by the State Water Pollution Control Agency concerned, the Engineering Section, Missouri Basin Health Council recommends the following for consideration by the member States as a tentative guide for water pollution control activities in the Missouri Drainage Basin:
>
> 1. Toxic substances including metallic ions, phenolic compounds, oils, alkalies, and acids should be virtually eliminated from sewage effluents.
>
> 2. Removal of settleable and floating solids to prevent sludge banks, floating materials, and nuisance conditions should be required as the minimum acceptable treatment.
>
> 3. For industrial wastes similar in nature to municipal wastes, treatment should be based on the same premise as recommended for municipalities. For industrial wastes not comparable to municipal wastes, treatment should be provided as necessary to prevent deterioration of water quality for beneficial uses in the receiving stream.
>
> 4. Additional treatment over that specified in item 2 above should be provided as necessary to protect downstream water uses. Quality objectives for certain water uses are:

---

*Action by Engineering Section, Missouri Basin Health Council on Jan. 7, 1954, reaffirmed the Guide and eliminated the qualification "tentative".

(a) For water serving as a source of domestic supply, raw water bacteriological quality should conform to that recommended in "Manual of Recommended Water Sanitation Practices, 1946, Public Health Bulletin #296," pages 11-13.

(b) For bathing or swimming waters, monthly arithmetical average 'most probable number' of coliform organisms should not exceed 1,000 per 100 ml. during any month of the recreation season; nor exceed this number in more than 20 percent of the samples examined during any such month; nor exceed 2,400 per 100 ml. on any day. For nonbathing or nonswimming waters, the monthly arithmetical average 'most probable number' of coliform organisms should not exceed 5,000 per 100 ml. in any month of the recreational season, nor should exceed this number in more than 20 percent of the samples examined during any such month.'

(c) For fish and aquatic life a minimum oxygen concentration of 5.0 ppm. is desirable in waters otherwise offering suitable fishery habitat, with 6.0 ppm. for trout streams.

(d) For bacteriological quality of irrigation water:

(1) Sewage used for irrigation of forage crops should be given treatment insuring a consistent reduction in coliform bacterial of not less than 90 percent.

(2) Sewage used for irrigation of human food crops should be given treatment insuring a consistent reduction (a) in suspended solids of not less than 75%, (b) in 5 day 20° C. B.O.D. of not less than 75% and (c) in coliform bacteria of not less than 98 percent, unless discharged into a stream where the volume of dilution water, available during the low flow periods during which irrigation diversions may occur, is at least 10 times greater than the anticipated maximum daily volume of sewage, in which case a bacterial reduction of 90 percent may be acceptable.

Provided, however, that where the time of passage from plant discharge to irrigation diversion is such as to permit the normal death rate of bacterial as evidenced by the die-away curve to provide equivalent bacterial reduction, the requirements of (1) and (2) above may be appropriately modified."

Exhibit 4

STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

Statement of Policy
on
Stream Flow Augmentation

Flow regulation may have a marked effect upon low flows and must, therefore, be given due consideration by the Commission in adoption of stream classifications, standards, degree of treatment requirements for control of sewage and industrial wastes, and other matters relating to control of pollution. The establishment of a regulated minimum discharge may be of vital economic importance to a number of municipalities and industries, and particularly those in the Twin Cities Metropolitan Area.

It is the sense of the Commission that allowance should not be made in the design of treatment works for possible low flow augmentation which may be provided in the future unless such flow augmentation or minimum flow to be provided is dependable under applicable laws and regulations.

The Commission believes that flow augmentation should not be used at any time as a substitute for operation of sewage or industrial waste treatment works at maximum capability, or for other methods of controlling wastes at the source, but should, instead be a supplement to the best operation of such treatment works in order to provide higher water quality than could otherwise be obtained. Low flow augmentation may, however, become an economic necessity for avoidance of gross pollution conditions during critical periods in the densely populated or highly industrialized areas of the state, as the maximum degree of treatment of which conventional treatment works are capable is approached in the future.

Adopted by the Commission on December 21, 1962.

REPORT ON BACTERIOLOGICAL POLLUTION FROM MUNICIPAL AND INDUSTRIAL WASTE DISCHARGES

ON THE

RED RIVER OF THE NORTH

U. S. Department of Health, Education, & Welfare
Federal Water Pollution Control Administration
Robert A. Taft Sanitary Engineering Center
Cincinati, Ohio

February 1966

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INTRODUCTION

On September 14, 1965, a Conference attended by representatives of the states of Minnesota and North Dakota and Department of Health, Education, and Welfare was held in Fargo, North Dakota, to evaluate the effects of pollution on the interstate waters of the Red River of the North, and to recommend abatement action if such pollution could be demonstrated. The representative of North Dakota expressed a desire to ascertain the degree of bacteriological pollution from each of the sources listed in the Federal report, and recommended further study to pinpoint the extremely high bacterial densities in the river, so that effective remedial action might be taken. Representatives of the Federal government and Minnesota concurred.

The request resulted in a bacteriological survey of the significant sources of municipal and industrial waste discharges in the study area from October 24 through 29, 1965, by the Technical Advisory and Investigations Activities of the R. A. Taft Sanitary Engineering Center. Excellent cooperation was received during this study from the personnel of the American Crystal Sugar

Company and from the municipal treatment plant employees of Fargo, North Dakota and Moorhead, Minnesota. Gratitude is also expressed to the University of North Dakota at Grand Forks for providing laboratory accommodations. Bacterial survival studies were conducted by the Bacterial Studies Unit of the Basic and Applied Sciences Program at the Robert A. Taft Sanitary Engineering Center.

SUMMARY AND CONCLUSIONS

Wastes from the Fargo and Moorhead municipal treatment plants and from the American Crystal Sugar Company plant at Moorhead caused the coliform densities in the Red River of the North to increase from 500/100 ml and 100/100 ml for total and fecal coliform respectively to 75,000/100 ml and 15,500/100 ml at a point below these sources of wastes. Approximately 58 percent of the increase resulted from Fargo domestic sewage; 36 percent from Moorhead domestic sewage; and 5.5 percent from the American Crystal Sugar plant. The remaining 0.5 percent was the result of upstream residuals.

Pathogenic Salmonella were recovered in each of the three waste sources and were recovered in the river below these discharges. Salmonella were not recovered at the upstream reference point. The source of pathogenic bacteria found in the Red River of the North is the municipal and industrial waste discharges at Fargo and Moorhead.

To maintain total coliform densities in the Red River of the North below 5000/100 ml at critical periods of river flow, it will be necessary to reduce coliform concentrations by at least 99.5 percent in the waste discharges of the municipal plants at Fargo and

Moorhead and by at least 96 percent in the American Crystal Sugar plant effluent. These reductions should be attained by effective disinfection at the municipal waste treatment plants as previously recommended in the Federal report presented at the first session of the Conference. It may be possible for the American Crystal Sugar Company to effect the necessary reduction by other means but if these are not successful, disinfection of the waste effluent will be required.

To maintain total coliform densities in the Red River of the North below 5000/100 ml during critical river flows, the American Crystal Sugar Company plant at East Grand Forks must reduce coliform concentrations by at least 98.8 percent. Salmonella were recovered within the holding pond at this plant and the potential discharge of this pathogen could create a health hazard in the receiving stream. As shown in the previous Federal report and illustrated further in the bacterial survival tests associated with this report, Salmonella is an extremely persistent organism, particularly at the low temperatures characteristic of this waste discharge. The bacterial survival studies at this plant indicated that nutrients added in the processing of sugar beets promote growth and multiplication of Salmonella. To reduce the health hazard associated with Salmonella organisms, these nutrients should be reduced or eliminated as soon as possible.

To maintain a total coliform maximum below 5000/100 ml in the Red Lake River during critical river flows, the American Crystal Sugar

Company plant at Crookston must effect a reduction in total coliform densities of at least 98.5 percent. As with the ACS-Moorhead plant, the necessary reductions at ACS-Crookston and ACS-EGF could possibly be obtained by means other than disinfection but if these are not successful, disinfection will be the only alternative. Discharge of the combined ash drain waste and sanitary sewage at the ACS-Crookston sugar plant showed total and fecal coliform densities of 16,000,000 /100 ml and 630,000/100 ml respectively. The present treatment and chlorination of this waste were not effective and remedial measures to correct this situation should be taken as soon as possible. Bacterial survival studies at this plant showed that, given favorable temperature and nutrient conditions, _Salmonella_ can multiply in waste water. No _Salmonella_ were found in the holding pond at this plant, but favorable nutrient levels for growth of this organism should be reduced or eliminated as soon as possible.

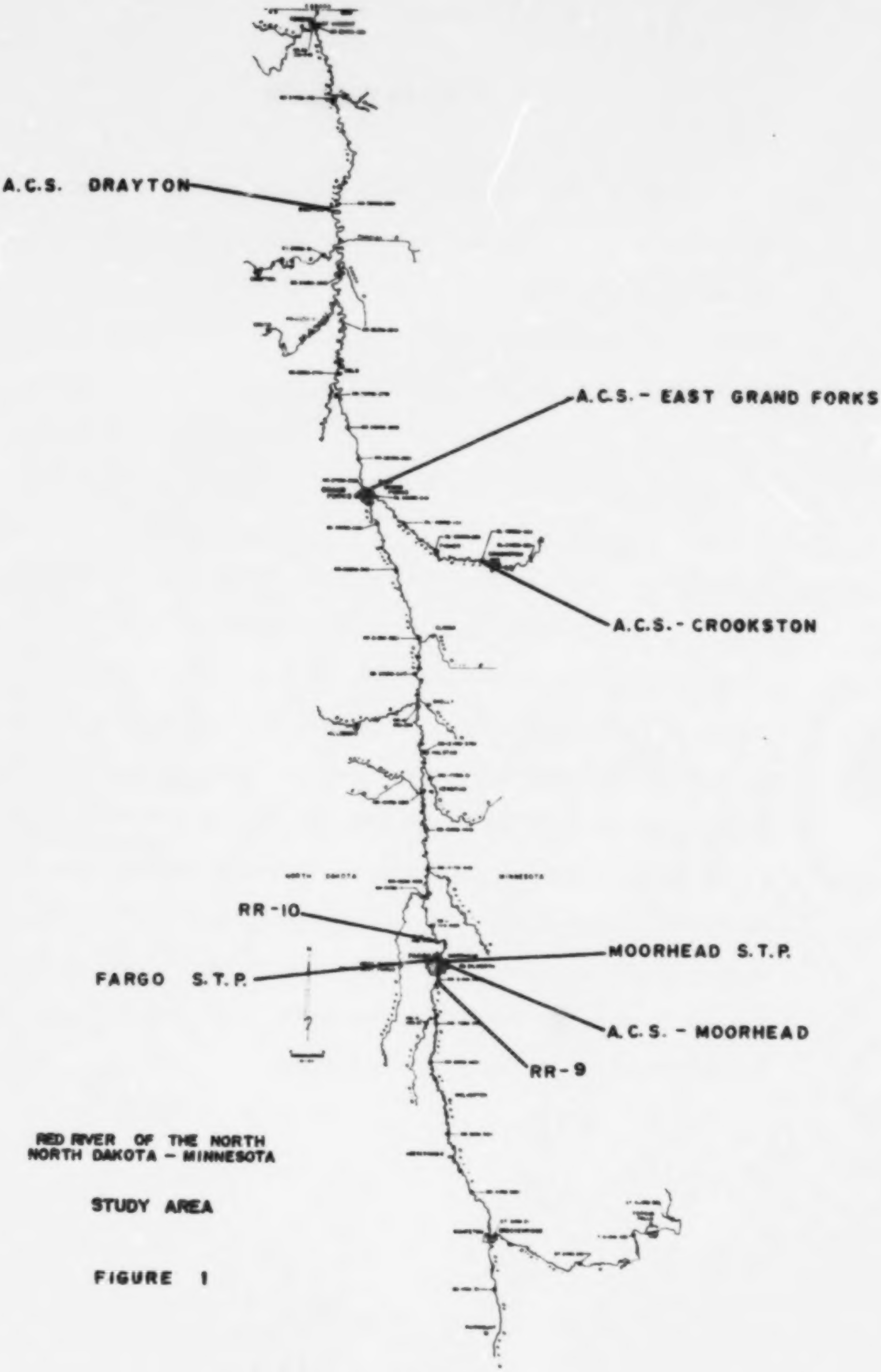
Preliminary data gathered at the American Crystal Sugar Company plant at Drayton indicated that coliform densities must be reduced by 90 percent to attain a level of not more than 5000/100 ml in the Red River of the North.

* * * * * * * * *

Sewage and industrial wastes discharged to the Red River of the North and the Red Lake River from Minnesota cause pollution in the interstate waters of the Red River of the North which endangers the health or welfare of persons in North Dakota and, therefore, is subject to abatement under the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et seq.). Sewage discharged to the Red River of the North from North Dakota causes pollution in the interstate waters of the Red River of the North which endangers the health or welfare of persons in Minnesota and, therefore, is subject to abatement under the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et seq.).

SAMPLING PROCEDURE

Sampling was conducted primarily on specific sources of waste discharge that showed excessive bacteriological pollution during the 1964-65 studies. The influent and effluent of the waste water holding ponds of the American Crystal Sugar Company plants at Moorhead, Crookston and East Grand Forks, Minnesota were sampled as well as selected in-plant locations at Crookston and East Grand Forks. Sampling points within the sugar plant included (1) the source of water supply, (2) the flume and wash water before use, (3) the flume water after use, (4) the wash water after use, and (5) the ash drain and floor drain water after use. At the East Grand Forks plant, sampling within the lagoon was conducted to define bacterial reduction with respect to time of storage. Samples of soil scraped from sugar beets and soil from the beet fields were also collected. The effluents from the municipal treatment plants at Fargo, North Dakota and Moorhead, Minnesota were sampled as well as the Red River of the North upstream and downstream of Fargo-Moorhead, corresponding to stations RR-9 and RR-10 of the Federal report presented at the Conference in September 1965. A description of each sampling station is contained in Table I.


A.C.S. DRAYTON
A.C.S. - EAST GRAND FORKS
A.C.S. - CROOKSTON
NORTH DAKOTA
MINNESOTA
RR-10
MOORHEAD S.T.P.
FARGO S.T.P.
A.C.S. - MOORHEAD
RR-9

RED RIVER OF THE NORTH
NORTH DAKOTA - MINNESOTA

STUDY AREA

FIGURE 1

Table I

RED RIVER OF THE NORTH

Bacteriological Survey - October 1965

Sampling Locations

Station No.	Description
SG-1	Source of water supply ACS-EGF
SG-2	Seal tank water - ACS-EGF
SG-3	Flume water after use - ACS-EGF
SG-4	Wash water after use - ACS-EGF
SG-5	Influent to lagoon - ACS-EGF
SG-6	End of second bay - ACS-EGF lagoon
SG-7	End of third bay - ACS-EGF lagoon
SG-8	End of fifth bay - ACS-EGF lagoon
RR-9	Red River above Fargo-Moorhead R.M. 462
RR-10	Red River below Fargo-Moorhead R.M. 441
SM-11	Influent to lagoon - ACS-Moorhead
SM-13	Effluent of lagoon - ACS-Moorhead
F-14	Effluent - municipal sewage - Fargo
M-15	Effluent - municipal sewage - Moorhead
SC-16	Source of water supply - ACS - Crookston
SC-17	Seal tank water - ACS - Crookston
SC-18	Flume water after use - ACS - Crookston
SC-19	Wash water after use - ACS - Crookston
SC-20	Influent to lagoon - ACS - Crookston
SC-21	Effluent from lagoon - ACS - Crookston

Table I (Cont.)

RED RIVER OF THE NORTH

Bacteriological Survey - October 1965

Sampling Locations

Station No.	Description
SC-22	Ash drain water - ACS - Crookston
SC-23	Chlorinated sanitary + ash drain effluent - Crookston
SG-24	Ash drain water - ACS-EGF
SD-25	Influent to lagoon at ACS - Drayton
SD-26	Effluent from lagoon - ACS - Drayton
SG-27	End of first bay, ACS-EGF lagoon
SG-28	End of fourth bay, ACS-EGF lagoon
SG-29	End of sixth bay, ACS-EGF lagoon
SG-30	End of seventh bay, ACS-EGF lagoon
SG-31	End of eighth bay, ACS-EGF lagoon
SG-32	End of ninth bay, ACS-EGF lagoon
SG-33	End of eleventh bay, ACS-EGF lagoon

Analyses made in the field consisted of total and fecal coliform densities, fecal streptococcus densities, pH and total and volatile suspended solids. Additionally, several points were sampled for Salmonella organisms. Samples were returned to the Robert A. Taft Sanitary Engineering Center for bacterial survival and nutrient level studies.

DISCUSSION OF BACTERIOLOGICAL POLLUTION

The significance of indicator organisms was discussed at length in the Federal report presented at the first session of the Conference on the Red River of the North. However, it may be well to summarize certain of the conclusions of that report.

Coliform bacteria universally occur in sanitary wastes and while not usually harmful in themselves can be used as an indication of the probable presence of pathogenic organisms. Numerous state and interstate water pollution control agencies have used coliform densities as one basis for water quality objectives. Both the states of Minnesota and North Dakota subscribe to a maximum limit of 5000/100 ml average total coliform. An objection to the use of total coliform densities has been that their origin is not exclusively from fecal sources. However, the Eschericia or fecal species of the coliform group is derived exclusively from human or animal excreta and its presence is evidence of fecal contamination. Therefore, it is necessary to consider all occurrences of fecal coliform organisms as indicative of dangerous contamination.

Interest has been expressed in the use of the fecal streptococci as an indicator of potential pathogenic contamination by waste discharges. This stems from the fact that this group is characteristic of fecal pollution; that they do not multiply in surface waters and they rarely occur on surface soil or vegetation not contaminated by sewage. Because of these characteristics, the fecal streptococcus has been used as a supplementary indicator.

Salmonella is a genus of bacteria pathogenic to man and to warm-blooded animals. These organisms are discharged in the intestinal wastes from infected man and animals and, because of their disease-producing capabilities, their presence in receiving waters constitutes a definite health hazard through direct or indirect contact with these waters. Previously, it has been accepted sanitary practice to describe deleterious bacteriological quality of water exclusively by coliform densities because the relatively low densities of Salmonella with relation to coliform densities made isolation difficult. New techniques have recently been developed, however, which makes isolation of these pathogens practicable even at relatively low coliform densities.

FARGO-MOORHEAD

The major sources of bacteriological pollution in this area are the unchlorinated effluents from the municipal waste treatment plants at Fargo and Moorhead and the industrial waste water released from the American Crystal Sugar Company plant at Moorhead when it is in operation.

The mean total coliform density discharged in the effluent from the Fargo municipal plant was 4,600,000/100 ml with values recorded as high as 14,000,000/100 ml. The fecal coliform density averaged 1,300,000/100 ml with values as high as 2,300,000/100 ml. Fecal streptococcus densities from this plant averaged 285,000/100 ml with a maximum value of 900,000/100 ml.

The Moorhead municipal waste treatment plant discharged densities of 6,100,000/100 ml for total coliform and 1,600,000/100 ml for fecal coliform with maximum values of 11,000,000/100 ml and 3,300,000/100 ml respectively. The fecal streptococcus density in the effluent was 330,000/100 ml with a maximum of 650,000/100 ml.

Total coliform densities from the American Crystal Sugar Company plant in Moorhead averaged 530,000/100 ml with fecal coliform densities of 130,000/100 ml. Individual values were as high as 1,100,000/100 ml and 240,000/100 ml respectively. Average fecal streptococcus densities were 175,000/100 ml and exhibited a maximum value of 760,000/100 ml.

The sampling station at R.M. 462 (RR-9) upstream of Fargo-Moorhead is above any source of human or industrial wastes originating in the Fargo-Moorhead area which may affect the bacteriological quality of the stream. Therefore, any deterioration in the bacteriological quality at this point is most likely the result of land runoff or of livestock and animal pollution. The river downstream of R.M. 462 flows through a highly urbanized area. Little or no livestock pollution could be expected to enter the river in this reach. The sampling station downstream of Fargo-Moorhead at R.M. 441 (RR-10) is about 1/2 mile below the Fargo sewage treatment plant, and is downstream of all sources of wastes in the Fargo-Moorhead area. Any bacterial increase at R.M. 441 over R.M. 462 is a result of the contribution made by the domestic and industrial wastes at Fargo-Moorhead. In the Red River of the North at R.M. 462 (RR-9), the total and fecal coliform densities averaged 550/100 ml and 100/100 ml respectively. Fecal streptococcus values were 100/100 ml. These values are relatively low. At R.M. 441 (RR-10), however, the total and fecal coliform densities averaged 75,000/100 ml and 15,500/100 ml respectively, with a fecal streptococcus density of 5900/100 ml.

Table II shows that the bacterial pollution in the Red River of the North can be entirely accounted for by the upstream residual and the sources of waste in the Fargo-Moorhead area. Of the coliform densities observed in the river, approximately 94 percent was contributed from the municipal waste treatment facilities, of which 58 percent was from Fargo and 36 percent from Moorhead. The remaining 6 percent resulted from the American Crystal Sugar Company effluent. Only a negligible amount of the bacterial pollution in the Red River below Fargo-Moorhead is the result of natural land runoff or agricultural drainage. The fecal streptococcus densities observed consisted of 46 percent from Fargo, 25.5 percent from Moorhead, and 27 percent from the American Crystal Sugar Company. Again, only a very small quantity in the river results from other than these three waste sources.

To insure that the total coliform density in the Red River below Fargo-Moorhead does not exceed the limit of 5000/100 ml at the once-in-ten-year monthly low flow of 65 cfs, which occurs in September,

Table II

RELATIVE CONTRIBUTION OF BACTERIAL POLLUTION
to the Red River of the North at
Fargo - Moorhead

Source	Total Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Strep MF/100 ml	Flow (MGD)
Fargo S.T.P.	4,600,000	1,300,000	285,000	5.13
Moorhead S.T.P.	6,100,000	1,600,000	330,000	2.45
A.C.S. Plant	530,000	130,000	175,000	4.9
R.M. 462 (RR-9)	550	100	100	422.0
R.M. 441 (RR-10)	75,000	15,500	5,900	430.0

Balance Equation

$$(Q \times \mathrm{MPN})\ \text{Fargo STP} + (Q \times \mathrm{MPN})\ \text{Moorhead STP} + (Q \times \mathrm{MPN})\ \text{ACS-Moorhead}$$
$$+ (Q \times \mathrm{MPN})\ \text{R.M. } 462 = (Q \times \mathrm{MPN})\ \text{R.M. } 441$$

Concentration at R.M. 441	Calculated	Observed
Total Coliform	95,000	75,000
Fecal Coliform	26,000	15,500
Fecal Streptococci	7,300	5,900

Percent Downstream Pollution from Each Source

Source	Total Coliform	Fecal Coliform	Fecal Strep
Fargo S.T.P.	57.5%	59 %	46 %
Moorhead S.T.P.	36 %	35 %	25.5%
A.C.S. Plant	6 %	5.5%	27 %
Upstream	0.5%	0.5%	1.5%

it will be necessary to reduce present coliform densities in these wastes by at least 99.5 percent for the municipal plants and by at least 96 percent for the American Crystal Sugar effluent. These reductions can be attained by effective disinfection in the case of the municipal treatment plants as previously recommended in the Federal report presented at the first session of the Conference. At the American Crystal Sugar plant, the recommendation in the Federal report for storage of wastes during the campaign and release during high spring flows will also accomplish the necessary reduction in coliform organisms to achieve the stream standard of 5000/100 ml.

Salmonella sampling was conducted on the effluent of each of the three waste sources; at the influent to the waste water holding pond at the sugar plant, and at the river stations immediately above and below these sources of waste. *Salmonella* was recovered from each of the waste effluents and at the river station below these discharges. Significantly, no *Salmonella* was isolated in the river above the sources of waste, thereby indicating that the source of the pathogenic *Salmonella* isolated in the river below the Fargo-Moorhead area was the discharges from the two municipal treatment plants and from the beet sugar plant. The persistence of *Salmonella* organisms in the downstream waters of the Red River of the North was demonstrated in the Federal report presented at the first session of the Conference.

WASTE WATER HOLDING PONDS

ACS - East Grand Forks

The waste water holding pond at ACS-East Grand Forks is a flow-through type, consisting of eleven bays in series. Since the 1965 campaign did not begin at this plant until October 4, the wastes resulting from the campaign had reached only to about the middle of the ninth bay when the survey began and were only beginning to leave the holding pond when the survey ended. To obtain a representative sample of campaign wastes, sampling was conducted at the influent and at the end of the second, third and fifth bays on a regular basis. One sample was obtained from each of the other bays except for the fourth and eleventh bays, from which two samples were collected.

Figure II shows the results of this sampling plotted versus time of travel through the holding pond. The nutrients discharged in these wastes supported a four-fold increase in total coliform in a period of about eight days. From an influent of 12,300,000/100 ml, the total coliform density increased to 50,300,000/100 ml at the end of the third bay. This increase is associated with the non-fecal species of coliform organisms, since the fecal organisms showed no multiplication in this holding pond over their initial concentrations. From an influent density of 1,500,000/100 ml, the fecal coliform decreased to about 450,000/100 ml at the end of the second bay, a storage time of approximately 3.5 days. The density remained fairly constant for the next eight days, followed by a steady decrease

Table III

Bacteriological Densities
American Crystal Sugar Company - East Grand Forks
Waste Water Holding Pond

Station	Total Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Strepto-coccus mf/100 ml	Storage Time Days
SG-5	12,300,000	1,500,000	840,000	0
SG-27	11,000,000	495,000	48,000	.3
SG-6	28,000,000	420,000	700,000	3.6
SG-7	50,300,000	400,000	181,000	6.3
SG-28	7,900,000	110,000	50,000	8.9
SG-8	40,000,000	350,000	37,000	11.3
SG-29	7,900,000	220,000	65,000	14.3
SG-30	790,000	110,000	60,000	17.9
SG-31	13,000,000	49,000	37,000	21.3
SG-32	1,700,000	79,000	5,300	24.6
SG-33	350,000	1,400	400	31.5

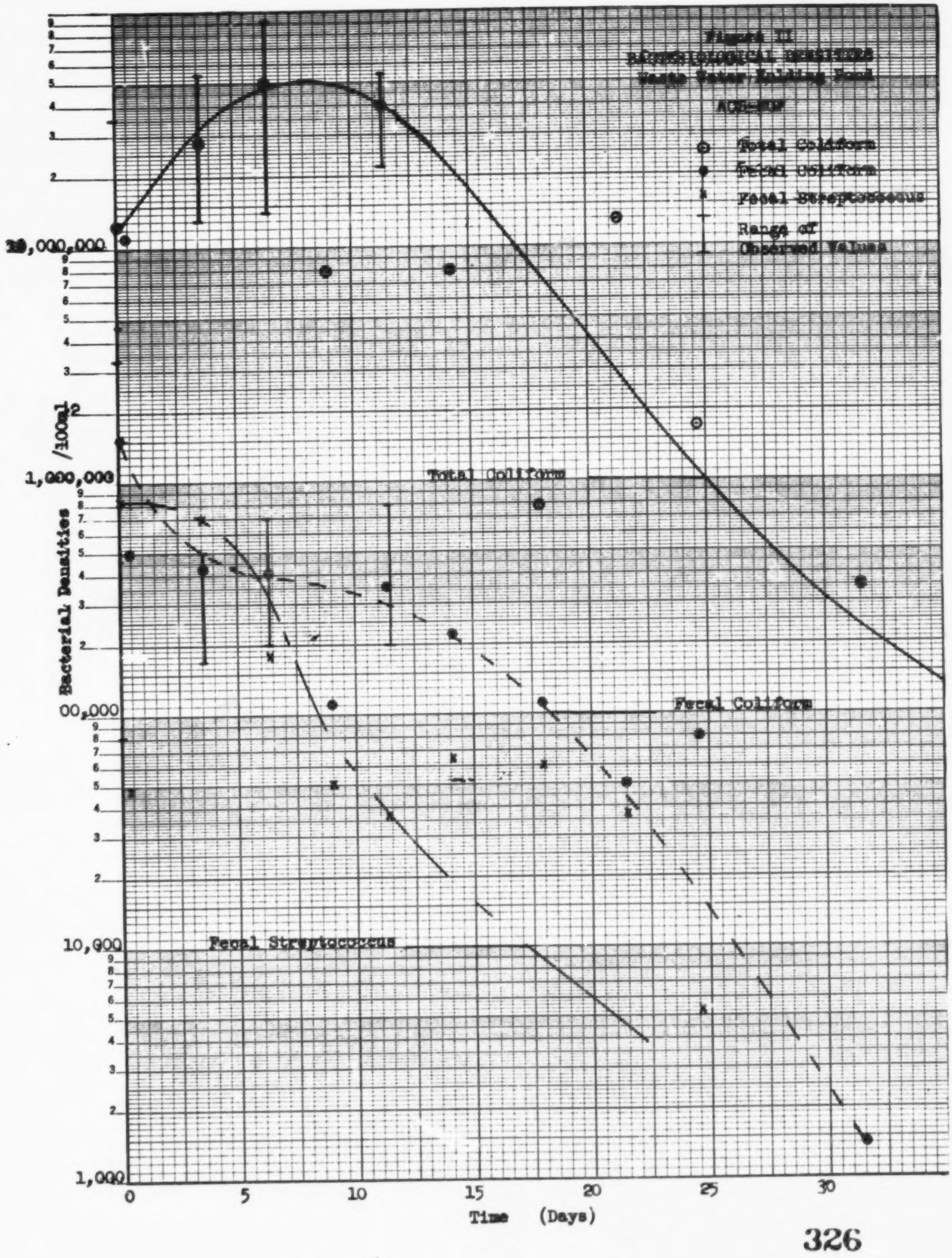


Figure 11
BACTERIOLOGICAL DENSITIES
Waste Water Holding Pond
Total Coliform
Fecal Coliform
Fecal Streptococcus
Range of Observed Values
Total Coliform
Fecal Coliform
Fecal Streptococcus
Bacterial Densities /100ml
10,000,000
1,000,000
100,000
10,000
1,000
Time (Days)
0
5
10
15
20
25
30

until, at the effluent, the fecal coliform density was 1400/100 ml. Fecal streptococcus densities declined rapidly, compared to the coliform organisms. Influent and effluent densities averaged 840,000/100 ml and 400/100 ml respectively. Removal efficiencies in this pond were about 97 percent for total coliform, 99 percent for fecal coliform, and 99.5 percent for fecal streptococcus. Storage time to accomplish these reductions was approximately 32 days. The extraordinarily slow rate of die-off is attributed to the nutrients discharged in the wastes, which maintained the fecal coliform densities at a high level for a long period and actually promoted a multiplication in the total numbers of coliform organisms.

To maintain the total coliform density of the Red River of the North below 5000/100 ml, the East Grand Forks sugar plant may not discharge densities greater than 150,000/100 ml. This value represents a reduction of 98.8 percent based on waste influent concentrations and is predicated on a release of 4.5 MGD at the once-in-ten-year low monthly flow for September of 265 cfs, with an upstream residual of 1000/100 ml. If this reduction is to be accomplished by storage, a holding time of at least 34 days will be necessary unless nutrients which cause multiplication of coliform densities are removed.

Salmonella colonies were not isolated in the influent wastes to the holding pond. However, at the end of the fifth bay, colonies were isolated indicating that the waste water in the holding pond is significantly contaminated with pathogenic organisms and represents a health hazard to anyone coming in contact with it. A laboratory study of the survival of Salmonella in beet sugar waste from this pond showed that, at temperatures of 10°C., five percent of the initial concentration still remained after fourteen days. This is a very slow rate of decline and is due to the fact that nutrients capable of supporting growth of these bacteria are present in sufficient quantities in these wastes. To reduce the health hazard associated with Salmonella organisms, it is imperative that these nutrients be reduced or eliminated as soon as possible.

ACS-Crookston

During this survey, the holding pond at ACS-Crookston was operated to give an average of eleven days storage time to the waste water. The influent to the holding pond averaged 5,300,000/100 ml and 1,700,000/100 ml for total and fecal coliforms respectively. Fecal streptococcus densities were too numerous to count. Total coliform in the effluent averaged 37,000,000/100 ml and fecal coliform densities were 12,500,000/100 ml. As illustrated in the sampling in the ACS-East Grand Forks holding pond, storage of this length is about the optimum time for peak densities of the total coliform. This is due to favorable nutrient levels in the wastes and a decreased temperature. In this case, fecal coliform densities multiplied as well as the total coliform.

To maintain a total coliform level below 5000/100 ml in the Red Lake River during the once-in-ten-year monthly low flow during the campaign season, the sugar plant must effect a reduction in total coliform densities of at least 98.5 percent. With an upstream residual of 1000/100 ml and a discharge from the holding pond of 3.5 MGD, the total coliform density in the effluent should not exceed 88,000/100 ml.

Salmonella sampling was conducted on both the influent and effluent to the holding pond. No colonies were isolated from either of these locations.

The ash drain waste from this plant is combined with the sanitary sewage and treated in an Imhoff tank followed by chlorination. The effluent is continually discharged to the river. Bacteriological densities of the separate ash drain waste were 50,000/100 ml for total coliform; 2100/100 ml for fecal coliform; and 1200/100 ml for fecal strep. Following treatment and chlorination of the two combined wastes, the respective counts were greater than 16,000,000/100 ml, 630,000/100 ml, and 2700/100 ml. Suspended solids discharged were 4490 mg/l. Treatment and chlorination of this waste are not presently effective and remedial measures to correct this situation should be taken as soon as possible.

ACS-Drayton

1965 was the first campaign season for the new ACS plant at Drayton and operation during the survey was erratic. For this reason, only two samples were taken of both the influent and the effluent to the waste water holding ponds. The effluent samples did

Table IV

Bacteriological Densities Within Sugar Plants

ACS-East Grand Forks

Description	Station No.	Total Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Strep MPN/100 ml
Water Supply	SG-1	29,000	13,000	900
Seal Tank	SG-2	4,100	980	120
Flume Water	SG-3	1,740,000	115,000	TNTC*
Wash Water	SG-4	4,070,000	120,000	251,000
Holding Pond Influent	SG-5	12,300,000	1,500,000	840,000
Ash Drain	SG-24	21,000	7,200	1,800

ACS-Crookston

Description	Station No.	Total Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Strep MPN/100 ml
Water Supply	SC-16	3,500	500	190
Seal Tank	SC-17	< 50	< 50	12
Flume Water	SC-18	1,880,000	1,040,000	6,000
Wash Water	SC-19	1,870,000	211,000	31,000
Holding Pond Influent	SC-20	5,300,000	1,660,000	TNTC*
Ash Drain	SC-22	50,000	2,100	1,200

* Too numerous to count.

not adequately reflect the bacterial concentration to be expected under normal operations because the discharge did not contain campaign wastes but the influent samples did represent campaign wastes. Total and fecal coliform concentrations in the influent were 1,350,000/100 ml and 490,000/100 ml, respectively. Fecal streptococcus densities were 2,660,000/100 ml. The excessively high fecal streptococci indicates very recent fecal contamination, suggesting the possibility of sanitary wastes being mixed with this influent.

To maintain a total coliform density in the Red River of the North below 5000/100 ml, the ACS plant at Drayton may discharge total coliform not exceeding 135,000/100 ml or a 90 percent reduction of the waste influent densities. This is based on a discharge of 5 MGD from the holding ponds at a river flow of 265 cfs, with an upstream residual of 1000/100 ml.

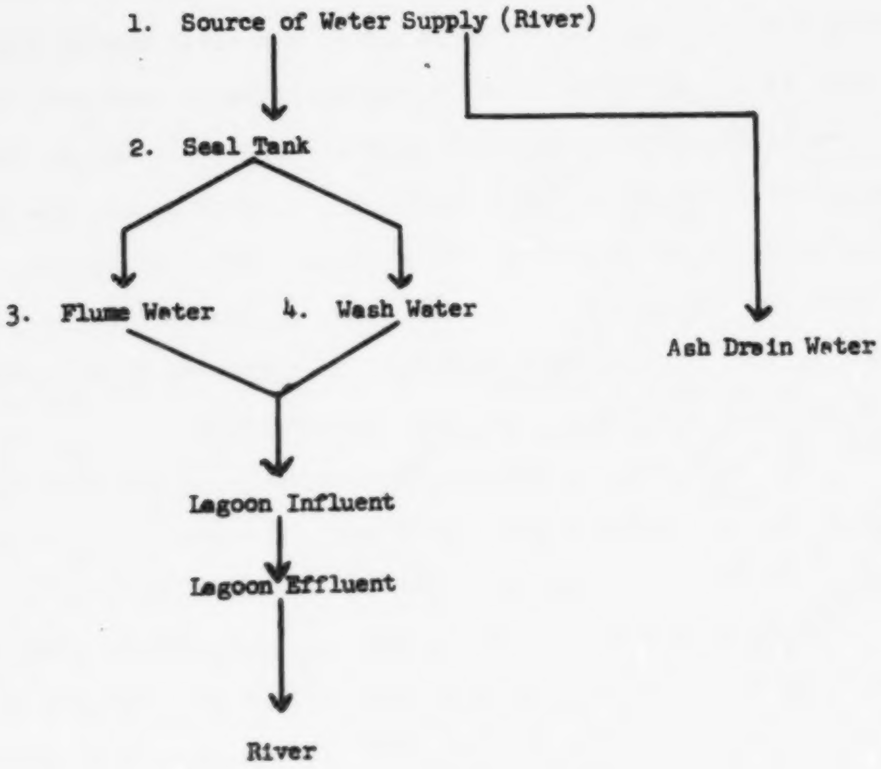
SUGAR BEET PLANTS - IN-PLANT SAMPLING

All of the American Crystal Sugar Company plants in the area operate with essentially the same process. In crystallizing the sugar, the raw juice is heated in large evaporators. Water from the river is pumped to cool the evaporators. The condensate and the heated cooling water enter the seal tank. This water is conveyed to the flume and used to transport beets into the plant. Beets as received are stored for later processing. Beets in the flume receive a preliminary washing and the elevated temperature of the water in the flume promotes thawing in beets that have frozen. Beets enter the factory and pass through rock and weed catchers. The flume water continues to the waste water holding pond. The beets are lifted out of the flume by the beet wheel or scroll, and dumped into the beet washer supplied by water from the seal tank. Leaving the washer, the beets are elevated into a hopper on an upper floor. The wash water is discharged to the holding pond. The remainder of the process is essentially closed with no escape of water. Lime wastes that occur from the purification process are conveyed to a separate lime waste pond. These lime wastes are released to the river only during periods of high flow in the spring. Another source of waste is the water used to cool and convey ashes from the furnaces. The floor drain water is mixed with this ash drain water. A diagrammatic sketch of the process is shown in Figure III.

At the Crookston plant, the incoming water supply had a total coliform density of 3500/100 ml and fecal coliform averaged 500/100 ml. Fecal streptococci were 190/100 ml. After the water is used for cooling, these counts dropped to less than 50/100 ml for the coliform and 12/100 ml for the strep. The seal tank water had a pH of 9.1 and an average temperature of 47°C. At the East Grand Forks plant, the water supply from the Red Lake River had total and fecal coliform densities of 28,900/100 ml and 13,000/100 ml respectively. These are, most likely, due to the discharge of very high bacterial concentrations from the waste water holding pond of the plant at Crookston, approximately 40 miles upstream. The seal tank water with an average temperature of 45°C. and a pH of 9.0 had densities of 4100/100 ml and 990/100 ml. Fecal strep were reduced from 860/100 ml to 120/100 ml. The high bacterial densities in the sugar processing wastes are introduced in

Figure III

Flow Diagram of Waste Water


1. Source of Water Supply (River)
2. Seal Tank
3. Flume Water
4. Wash Water
Ash Drain Water
Lagoon Influent
Lagoon Effluent
River

the flume water and wash water.

Table V shows that the total coliform density in dirt scraped from beets freshly unloaded at the plant was 490,000/gm. The total coliform concentrations of sliced beets taken immediately after the wash water tank were 13,000,000/gm and of beet trash removed from the flume was 17,200,000/gm. Surface peelings of beets taken from freshly stored piles showed a total coliform density of 2,800,000/gm. These densities would account for the excessive coliform in the flume and wash water at both plants. The high fecal streptococcus counts observed in the particulate material, ranging from 2200/gm. on the beet dirt to 3,300,000/gm. in the beet trash from the flume, would produce the densities observed in the flume and wash water.

The source of the fecal coliform densities in the flume and wash water is more difficult to ascertain. The mean fecal coliform densities of the flume and wash water at both plants averaged between 115,000/100 ml and 210,000/100 ml, except at the Crookston plant where the flume water showed an average fecal coliform concentration of 1,040,000/100 ml. The only particulate material to yield a significant density of fecal coliform was the sliced beets after washing with 172,000 /gm and the beet trash removed from the flume with 49,000 /gm. It is possible that growths adhering to the sides of the flume and wash tank may consist of fecal coliform that develop because of favorable temperature and nutrient material available. The presence of high densities of fecal coliform suggests hazardous contamination. These excessive bacterial densities must be reduced to acceptable levels at some point before discharge to the receiving stream.

Table V

Bacteriological Densities - Particulate Material

Description		Bacterial Count per Gram		
		Total Coliform	Fecal Coliform	Fecal Strep.
Beet Dirt*		490,000	10.9	2,200
Sliced Beets		13,000,000	172,000	580,000
Beet Trash**		17,200,000	49,000	3,800,000
Beet Surface Peelings		2,780,000	< 0.2	5,200
Wet Beet Field Soil		94	1.3	150
Dry Beet Field Soil		0.9	< 0.2	210
Beet Fertilizer (Artificial)	1.	< 0.2	< 0.2	1.4
	2.	< 0.2	< 0.2	0.2
	3.	< 0.2	< 0.2	< 0.2

* Composite scraped from 10-15 freshly unloaded beets.

** Stalks and weed material recovered from flume.

BACTERIAL SURVIVAL STUDIES

To interpret the significance of fecal coliform, fecal streptococci and *Salmonella* in beet sugar waste waters, samples from each of the in-plant locations at the ACS plants in Crookston and East Grand Forks, as well as the influent and effluent of the holding ponds from these plants, plus the ACS-Moorhead installation, were returned to the Robert A. Taft Sanitary Engineering Center for intensive analysis. The samples were shipped and received in a completely frozen state. They were then sterilized and reinoculated with a known quantity of fecal coliform, fecal streptococci and *Salmonella* of the typhimurium species. These inoculations were made in split samples containing a pure culture of the particular organism. Incubation was at approximately the temperature of collection and bacterial counts were made at the end of one day, two days, three days, seven days, and fourteen days. The results, in terms of percent of initial concentration remaining, are summarized in Table VI, and illustrated in figures contained in Appendix II.

Bacterial survival is influenced by, among other things, temperature, pH and available nutrients. The fecal coliform in the source of water supply from both plants showed a definite lag phase

Table VI

A) Fecal Coliform Survival Studies

ACS-Crookston

Description	Incubation Temp. °C.	% Remaining				
		1 day	2 days	3 days	7 days	14 days
Water Supply	20	63	65	51	6	< 1
Seal Tank	44.5	< 1	-	-	-	-
Flume Water	30	3	0.2	-	-	-
Wash Water	20	No Result	98	61	8	1
Ash Drain	20	79	42	28	0.6	-
Lagoon Influent	35	-	-	-	-	-
Lagoon Effluent	10	30	3.6	3.4	0.15	0.15
ACS-East Grand Forks						
Water Supply	20	84	84	84	14	-
Seal Tank	44.5	0.2	-	-	-	-
Flume Water	20	-	-	-	-	-
Wash Water	20	72	15	7.5	9.2	0.2
Ash Drain	20	47	54	69	28	1.9
Lagoon Influent	20	4	1.8	1	0.2	-
Lagoon Effluent	10	7.2	1.2	0.35	-	-
ACS-Moorhead						
Lagoon Influent	44.5	3.5	-	-	-	-
Lagoon Effluent	10	87	75	58	7.7	0.4

Table VI

B) Fecal Streptococcus Survival Series

ACS-Crookston

Description	Incubation Temp. °C.	% Remaining				
		1 day	2 days	3 days	7 days	14 days
Water Supply	20	98	82	47	1.7	-
Seal Tank	44.5	-	-	-	-	-
Flume Water	30	68	21	2	-	-
Wash Water	20	56	27	10	-	-
Ash Drain	20	51	28	12	-	-
Lagoon Influent	35	45	6	-	-	-
Lagoon Effluent	10	55	44	42	11	0.43

ACS-East Grand Forks

Description	Incubation Temp. °C.	1 day	2 days	3 days	7 days	14 days
Water Supply	20	122	76	47	-	-
Seal Tank	44.5	-	-	-	-	-
Flume Water	20	41	19	3.3	-	-
Wash Water	20	60	19	9.4	-	-
Ash Drain	20	25	5.2	1.4	-	-
Lagoon Influent	20	-	-	-	-	-
Lagoon Effluent	10	47	13	23	2.2	-

ACS-Moorhead

Description	Incubation Temp. °C.	1 day	2 days	3 days	7 days	14 days
Lagoon Influent	44.5	-	-	-	-	-
Lagoon Effluent	10	72	58	81	34	13

Table VI

C) Salmonella Survival Series

Description	Incubation Temp. °C.	% Remaining				
		1 day	2 days	3 days	7 days	14 days
ACS-Crookston						
Water Supply	20	92	69	25	2.4	0.2
Seal Tank	44.5		-	-	-	-
Flume Water	30	156	78	0.75	-	-
Wash Water	20	-	166	111	132	89
Ash Drain	20	94	77	63	3.4	-
Lagoon Influent	35	3.0	-	0.3	-	-
Lagoon Effluent	10	74	28	5.5	7.2	5
ACS-East Grand Forks						
Water Supply	20	106	137	128	2	-
Seal Tank	44.5	-	-	-	-	-
Flume Water	20	No Result	50	105	65	4.8
Wash Water	20	97	297	460	14	1.1
Ash Drain	20	134	104	132	27	0.71
Lagoon Influent	20	-	11	11	-	-
Lagoon Effluent	10	35	6	1.9	0.88	0.53
ACS-Moorhead						
Lagoon Influent	44.5	-	-	-	-	-
Lagoon Effluent	10	7.4	1.6	1.3	-	-

after an initial decrease. Concentrations remained relatively constant through the third day, followed by a gradual rate of dieoff. However, at the end of seven days the ACS-EGF water supply had 14 percent of its initial concentration remaining and, with the ACS-Crookston sample, 6 percent remained. The lag phase as well as the very gradual dieoff are, most likely, caused by a favorable nutrient level which, while not sufficient to encourage multiplication, is enough to sustain growth after an initial period of acclimatization. With the same environmental conditions, fecal streptococci showed a gradually accelerating dieaway in both water supplies until, by the end of the sixth day at ACS-EGF and the tenth day at ACS-Crookston, densities were virtually non-existent. However, in the first two days of incubation the organism showed an immediate adaptability and, in the case of the ACS-EGF sample, a 22 percent growth in one day. Salmonella in the ACS-Crookston source of water supply showed essentially the same shape of dieaway curve, with a slightly faster rate than the fecal streptococci, through the fourth day. There was then a sharp reduction in the rate of dieoff, indicating the persistence of these pathogenic organisms at low densities. In the ACS-EGF sample, there was a definite sustained multiplication for the first two days to a peak of 137 percent of initial concentration. The density was 2 percent of the initial concentration after seven days.

The samples collected from the seal tank illustrate the effect of temperature upon bacterial dieaway. At 44.5°C. the samples showed negligible or no densities of the three organisms after one day.

Fecal coliform in the spent flume water at both plants was reduced to insignificant quantities at the end of one day at an incubation temperature of 30°C. at ACS-Crookston and 20°C. at ACS-EGF. This, combined with the seal tank results, indicates the very high temperature sensitivity of fecal coliform. Salmonella and fecal streptococci, on the other hand, had significant concentrations remaining after three days. Salmonella in the ACS-Crookston flume water had a multiplication to 156 percent of the initial concentration in one day, followed by a rapid dieoff. In the ACS-EGF flume water, Salmonella, after an initial dieaway, increased from 50 percent to 105 percent of the initial concentration from the second to third day. The subsequent dieaway from this peak is very slow and about 5 percent of the initial density remained after 14 days. Since the difference between these two samples is the respective inoculation temperatures of 30°C. and 20°C., a warmer temperature will cause multiplication of Salmonella very quickly, followed by a very rapid dieaway. If the concern is with short term effects, this is the more critical condition. At a lower temperature, 20°C., the Salmonella multiply equally as much after a period of dieaway which is apparently an acclimatization phase. In addition, the dieaway after the peak is reached is much slower than that at the higher temperature of 30°C. From these considerations, it would be possible to obtain a sample of the flume water with neglegible fecal coliform counts but with significant quantities of Salmonella, a pathogenic organism. Apparently, the warmer temperature and the nutrients added to the raw water in transporting beets in the flume stimulate the growth of Salmonella while the effect on fecal coliform is the opposite, causing it to die away at a much greater rate than is shown in the raw water. The effect on the fecal streptococci is similar to the effect on fecal coliform causing them to be reduced at a faster rate than fecal streptococci in the raw water. Although the addition of beet waste and increased temperature had a measurably toxic effect on the growth of fecal streptococci compared to the raw water supply, this effect was not as pronounced as that of fecal coliform.

The samples of wash water from both plants show essentially the same pattern as the flume water for Salmonella and fecal streptococci, but on a much larger scale. All samples were incubated at 20°C. Salmonella multiplied in both samples; to 460 percent of initial concentration in three days in the ACS-EGF sample and to 166 percent in two days in the ACS-Crookston sample. Eighty-nine percent of the initial concentration remained after 14 days in the ACS-Crookston wash water. The nutrients added in the wash tank are sufficient to maintain Salmonella at very high levels and can cause multiplication to almost five times their initial value. The nutrients added in the wash tank have a much greater stimulating effect than the flume water. There is no immediate dieaway and the multiplication of the organism is far greater. The effect on fecal streptococci is to slow the dieoff rate as compared with the flume water. However, the dieoff is faster than that of the raw water, indicating that the additions made in the process have a toxic effect on the fecal streptococci. Fecal coliform in the wash water show a marked difference compared to those in the flume water incubated at the same temperature. Nutrients added in wash water retarded the rate of dieoff such that approximately 9 percent of the initial concentration remained at seven days. The dieoff rate of fecal coliform in the wash water at ACS-Crookston was about the same as that in the raw water supply. The ACS-EGF samples showed a faster dieoff in the wash water than the water supply for the first three days, but then remained constant until the seventh day when dieoff resumed at the same rate as in the water supply. The wash water operation was a prime source of nutrients which permitted the survival of indicator organisms and encouraged the multiplication of pathogenic Salmonella.

The holding pond effluent, which is a combination of flume water and wash water, would be expected to have a dieoff rate somewhere between that of the two constituents. The experimental data showed that it was a strong inhibitor of all three organisms. The reason for this phenomenon is not known. The sample from ACS-Crookston incubated at 35°C. showed no fecal streptococci after three days; and a small concentration (0.3 percent) of Salmonella after three days. The sample from ACS-EGF incubated at 20°C. showed 4 percent fecal coliform remaining after one day; no fecal streptococci after one day; and 11 percent Salmonella remaining after three days. The higher temperature of incubation generally caused faster dieoff and, of the three organisms, Salmonella was the most persistent. In all cases, except for the indeterminate fecal coliform results, the rate of dieoff was faster than that of either the flume water or wash water. The lab data indicated that something reacts in the combination of flume and wash water comprising the pond influent to inhibit bacterial action and promote rapid dieoff. The field data showed greater densities in the holding pond influents over either the flume water or wash water. The field samples were incubated at higher temperatures so that results may not be directly comparable with the laboratory data.

Analysis of holding pond effluent samples indicated the characteristics of bacterial survival in the water discharged to the river and are of primary interest. These samples were incubated at 10°C. and showed the effect of low temperatures in allowing persistence of the bacterial organisms. The fecal coliform died off fastest with neglegible quantities remaining after seven days. Salmonella had a fairly rapid initial dieoff but, after three days, there was a levelling off and concentrations declined very slowly. The fecal streptococci had the slowest dieoff rate with significant quantities as high as 11 percent remaining after seven days. This was almost an exact reversal of the bacterial survival in the water before it was used in the beet sugar process. In the raw water, fecal streptococci had the fastest dieaway. The initial dieoff of both Salmonella and fecal coliform was faster in the holding pond effluent than in the raw water, indicating that the net effect of the sugar beet process was to add material which had an inhibiting effect on the survival of these organisms, even though great quantities of fecal coliform and Salmonella were added during the process. However, the cooler temperature of the discharged wastes increases the persistence of Salmonella which will affect the receiving water for greater distances.

To summarize:

The net effect of sugar processing wastes on bacterial survival rates of fecal coliform is to cause a faster dieaway in the water discharged from the holding ponds than in the source of raw water. This is most likely due to the lower temperature of the discharged wastes and because of storage in the holding ponds. The effect on fecal streptococci is to slow the rate of dieoff compared to that of the raw water, indicating that the process has a slight stimulatory effect on this organism. Salmonella shows a faster rate of dieoff in the initial stages compared to that of the raw water, but is extremely persistent at lower densities. Of the three organisms, Salmonella may be expected to maintain significant concentrations for the longest period. Salmonella multiplies most profusely given favorable temperature and nutrient conditions, as shown by the wash water sample results. It may be possible, therefore, for a sample which is relatively low in fecal coliform or fecal streptococci to have significantly high densities of pathogenic Salmonella.

APPENDIX I

SUMMARY OF SURVEY DATA

Table A-1

Summary of Survey Data

Station		Total Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MF/100 ml	Suspended Solids		Temperature °C.	pH	Salmonella
					Total ppm	Volatile ppm			
SG-1	Avg.	29,000	13,000	900	43	16	12	8.2	Not Done
	Max.	54,000	35,000	2,600	72	18	21	8.3	
	Min.	2,400	600	180	22	10	7	7.9	
SG-2	Avg.	4,100	980	120	45	12	45	9.0	Not Done
	Max.	14,000	2,300	180			+ 50	9.3	
	Min.	330	330	85			35.5	8.8	
SG-3	Avg.	1,740,000	115,000	-	6,213	763	29	8.5	Not Done
	Max.	2,400,000	230,000		9,650	1050	39.5	8.8	
	Min.	1,300,000	11,000		4,490	590	22	8.1	
SG-4	Avg.	4,070,000	120,000	251,000	5,985	920	15	7.8	Not Done
	Max.						18.5	8.2	
	Min.						12	7.4	
SG-5	Avg.	12,300,000	1,500,000	840,000	8,540	890	27	8.6	Negative
	Max.	35,000,000	4,600,000		13,420	1130	33	8.8	
	Min.	3,300,000	80,000		5,530	740	20.5	8.0	
SG-6	Avg.	28,000,000	420,000	700,000	63	59	12	6.8	Not Done
	Max.	54,000,000	500,000	1780,000	108	88	13	6.9	
	Min.	13,000,000	170,000	58,000	34	-	11	6.8	
SG-7	Avg.	50,300,000	400,000	181,000	23	23	10	7.2	Not Done
	Max.	92,000,000	700,000	560,000	26	-	11	7.3	
	Min.	14,000,000	200,000	35,000	18	-	8	7.0	
SG-8	Avg.	40,000,000	350,000	37,000	38	29	8	7.7	Positive
	Max.	54,000,000	800,000	111,000	105	49	8.5	8.0	
	Min.	22,000,000	200,000	5,600	5	5	6	7.6	

Table A-1 (Cont.)

Summary of Survey Data

Station		Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MF/100ml	Suspended Solids Total ppm	Suspended Solids Volatile ppm	Temperature °C.	pH	Salmonella
RR-9	Avg.	550	100	100	23	10	8.5	8.3	Negative
	Max.	1,300	200	2,000	29	12	11	8.4	
	Min.	170	20	20	16	5	7	8.2	
RR-10	Avg.	75,000	15,500	5,900	17	7	10	8.3	Positive
	Max.	110,000	23,000	15,660	22	15	12.5	8.4	
	Min.	23,000	4,900	660	15	1	7.5	8.2	
SM-11	Avg.	773,000	54,000	4,000	8,905	975	43	8.5	Negative
	Max.	1,700,000	170,000	-	11,770	1,350	48	8.7	
	Min.	20,000	8,000	-	5,500	710	39.5	8.2	
SM-13	Avg.	530,000	130,000	175,000	36	29	11	7.4	Positive
	Max.	1,100,000	240,000	760,000	51	47	16	7.6	
	Min.	130,000	22,000	600	16	16	7	7.3	
F-14	Avg.	4,600,000	1,300,000	285,000	35	22	14.5	7.9	Positive
	Max.	14,000,000	2,300,000	900,000	45	31	16.5	8.0	
	Min.	1,100,000	460,000	76,000	29	16	12.5	7.8	
M-15	Avg.	6,100,000	1,600,000	330,000	46	43	15	7.5	Positive
	Max.	11,000,000	3,300,000	650,000	62	54	17.5	7.6	
	Min.	3,300,000	300,000	112,000	20	-	14	7.3	
SC-16	Avg.	3,500	500	190	28	15	10	8.2	Not Done
	Max.	7,000	1,100	270	36	17	15.5	8.3	
	Min.	1,300	170	115	16	13	7.5	7.9	
SC-17	Avg.	< 50	< 50	12	69	14	47	9.1	Not Done
	Max.	170	170	15	-	-	50	9.1	
	Min.	< 20	< 20	10	-	-	42.5	9.1	

Table A-1 (Cont.)

Summary of Survey Data

Station		Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MF/100ml	Suspended Solids		Temperature °C.	pH	Salmonella
					Total ppm	Volatile ppm			
SC-18	Avg.	1,880,000	1,040,000	6,000	7,990	1,063	40	8.9	Not Done
	Max.	3,500,000	3,500,000	-	9,740	1,420	46.5	9.0	
	Min.	17,000	13,000	-	7,500	860	28	8.7	
SC-19	Avg.	1,870,000	211,000	31,000	5,525	800	20	8.4	Not Done
	Max.	3,500,000	700,000	-	-	-	22	8.5	
	Min.	490,000	23,000	-	-	-	16	8.2	
SC-20	Avg.	5,300,000	1,660,000	-	8,870	1,055	36	8.4	Negative
	Max.	17,000,000	5,400,000	-	10,920	1,370	41	8.6	
	Min.	330,000	50,000	-	7,120	800	24	8.1	
SC-21	Avg.	37,000,000	12,500,000	3,700	11	8	8	7.6	Negative
	Max.	54,000,000	24,000,000	-	15	-	12.5	7.9	
	Min.	24,000,000	4,900,000	-	1	-	6	7.5	
SC-22	Avg.	50,000	2,100	1,200	-	-	20	8.8	
SC-23	Avg.	> 16,000,000	630,000	2,700	4,490	610	25	8.2	
SG-24	Avg.	21,000	7,200	1,800	-	-	15	8.7	
SD-25	Avg.	1,350,000	490,000	2660,000	-	-	21	8.8	
SD-26	Avg.	1,200,000	135,000	>130,000	-	-	7.5	6.2	
SG-27	Avg.	11,000,000	495,000	48,000	14	-	9	7.4	

Table A-1 (Cont.)

Summary of Survey Data

Station		Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MF/100ml	Suspended Solids Total ppm	Suspended Solids Volatile ppm	Temperature °C.	pH	Salmonella
SG-28	Avg.	7,900,000	110,000	50,000	68	48	19.5	7.0	
SG-29	Avg.	7,900,000	220,000	65,000	14	-	9	7.8	
SG-30	Avg.	790,000	110,000	60,000	18	-	9.5	7.7	
SG-31	Avg.	13,000,000	49,000	37,000	59	-	9.5	7.9	
SG-32	Avg.	1,700,000	79,000	5,300	19	19	8.5	7.9	
SG-33	Avg.	350,000	1,400	400	12	-	8.5	8.1	

APPENDIX II

BACTERIAL SURVIVAL STUDIES

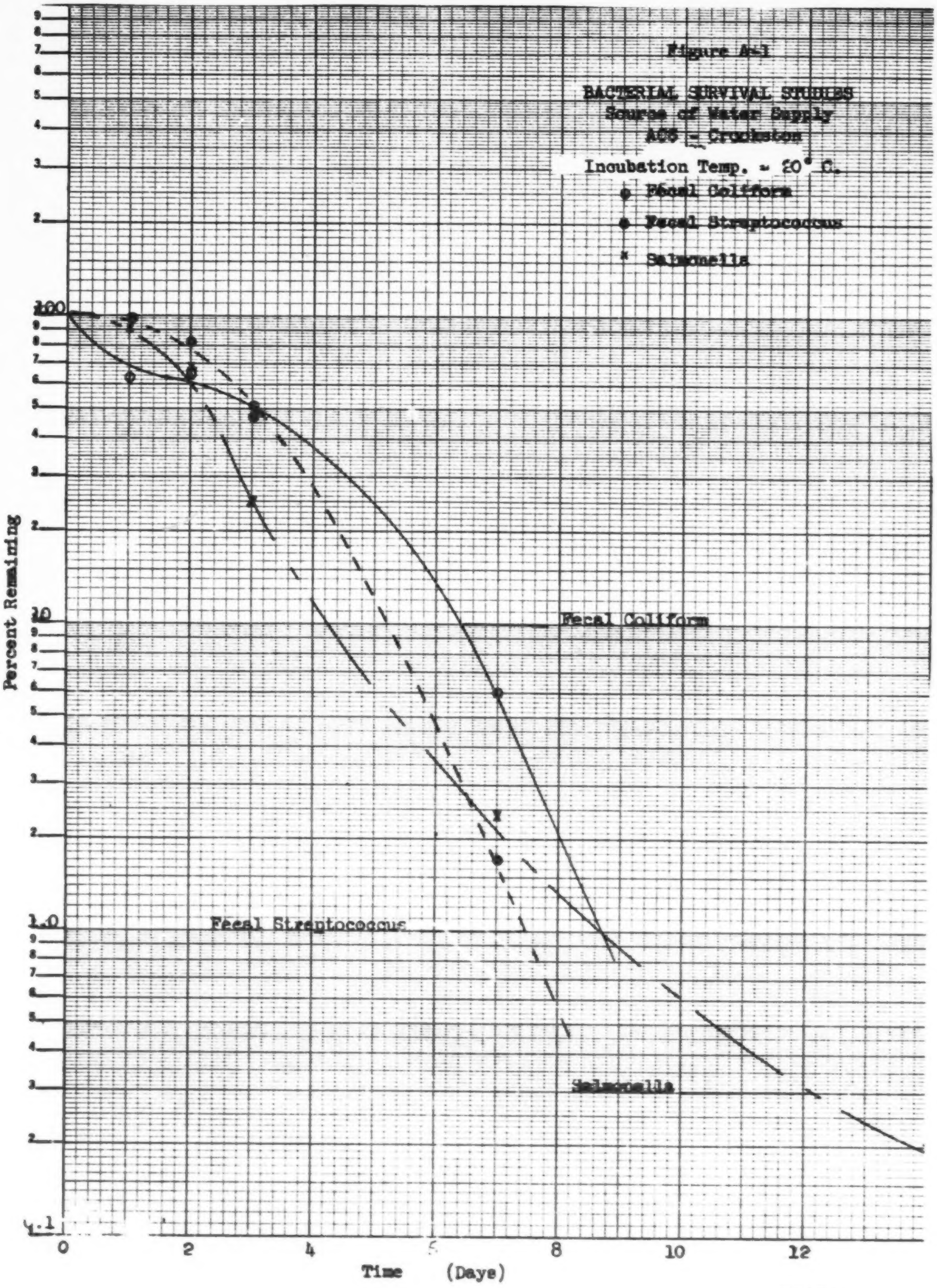


Figure A-1

BACTERIAL SURVIVAL STUDIES
Source of Water Supply
AC5 - Crookston

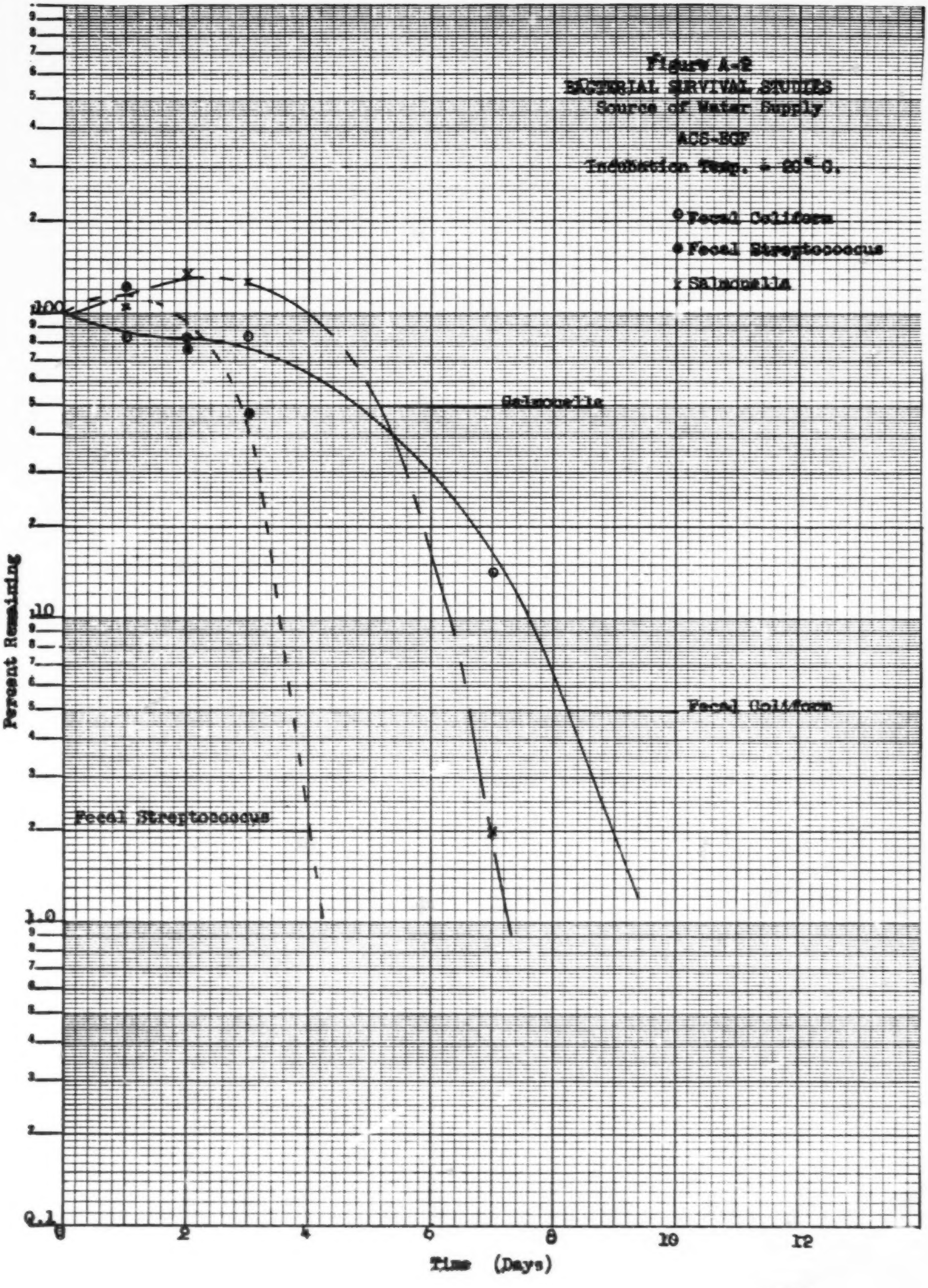


Figure A-2
BACTERIAL SURVIVAL STUDIES
Source of Water Supply
ACS-EGF
Incubation Temp. - 20° C.

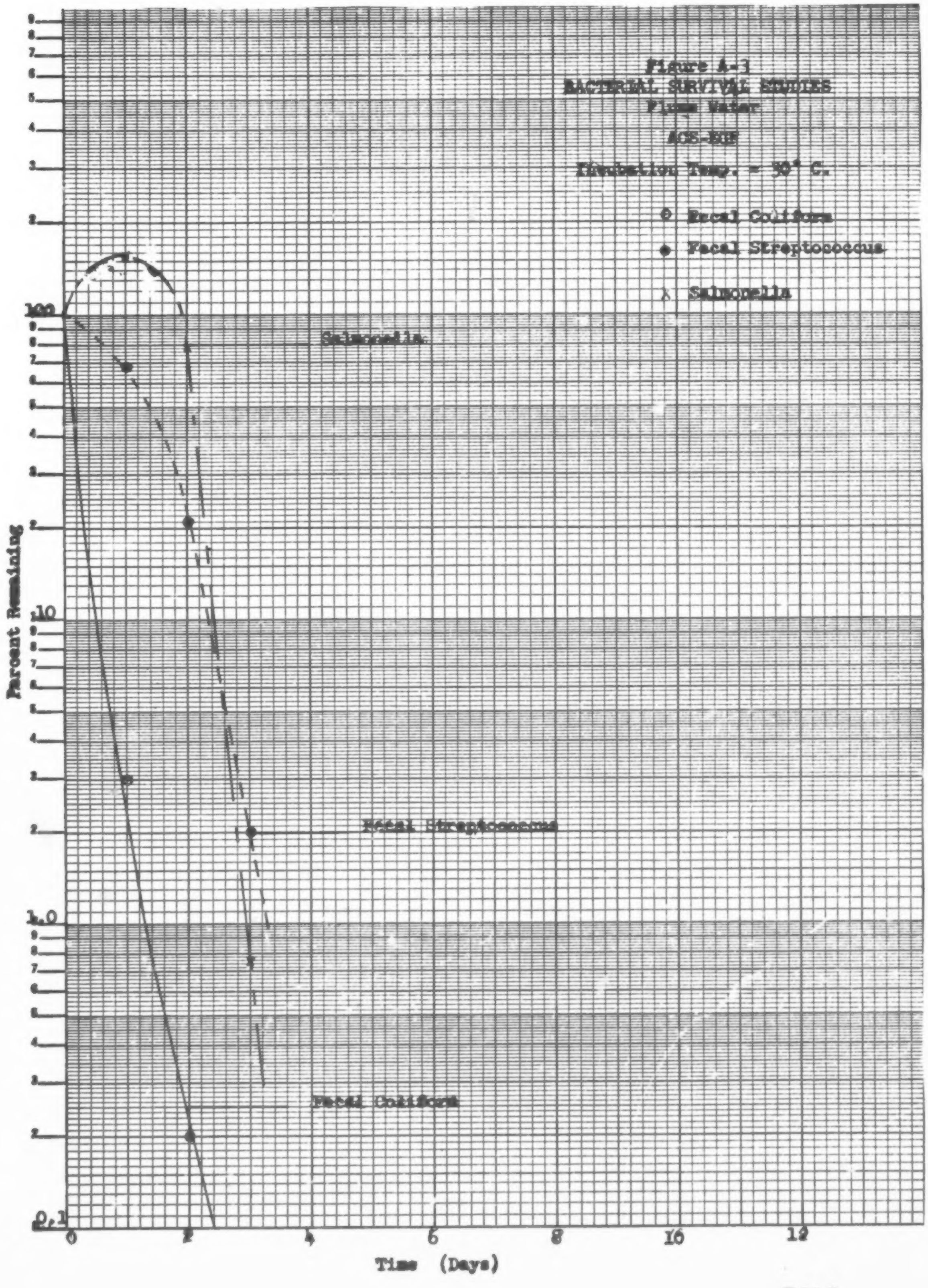


Figure A-3
BACTERIAL SURVIVAL STUDIES
Plume Water

ACS-EHF

Incubation Temp. = 30° C.

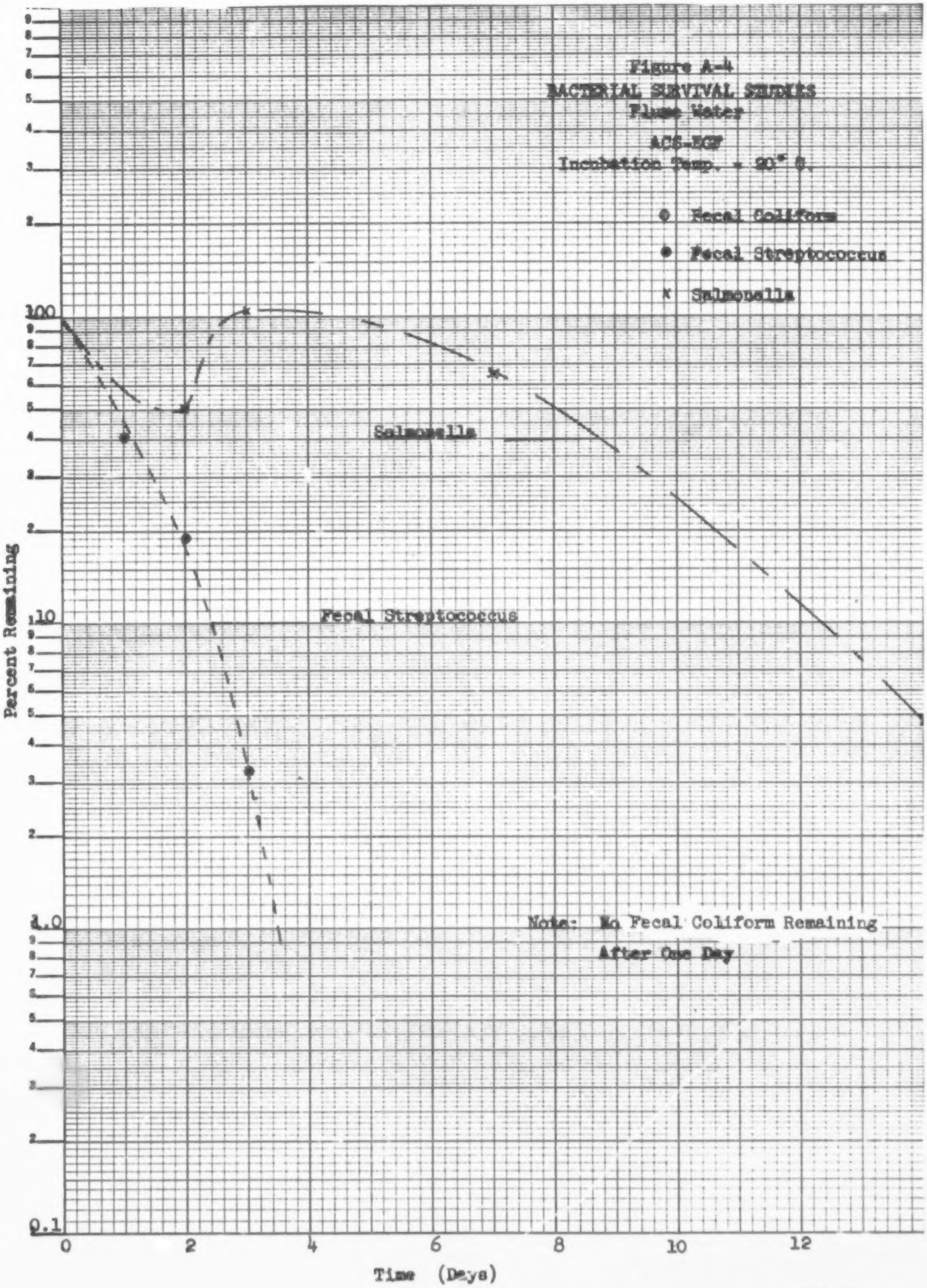


Figure A-4
BACTERIAL SURVIVAL STUDIES
Flume Water

ACS-EGF
Incubation Temp. = 20° C.

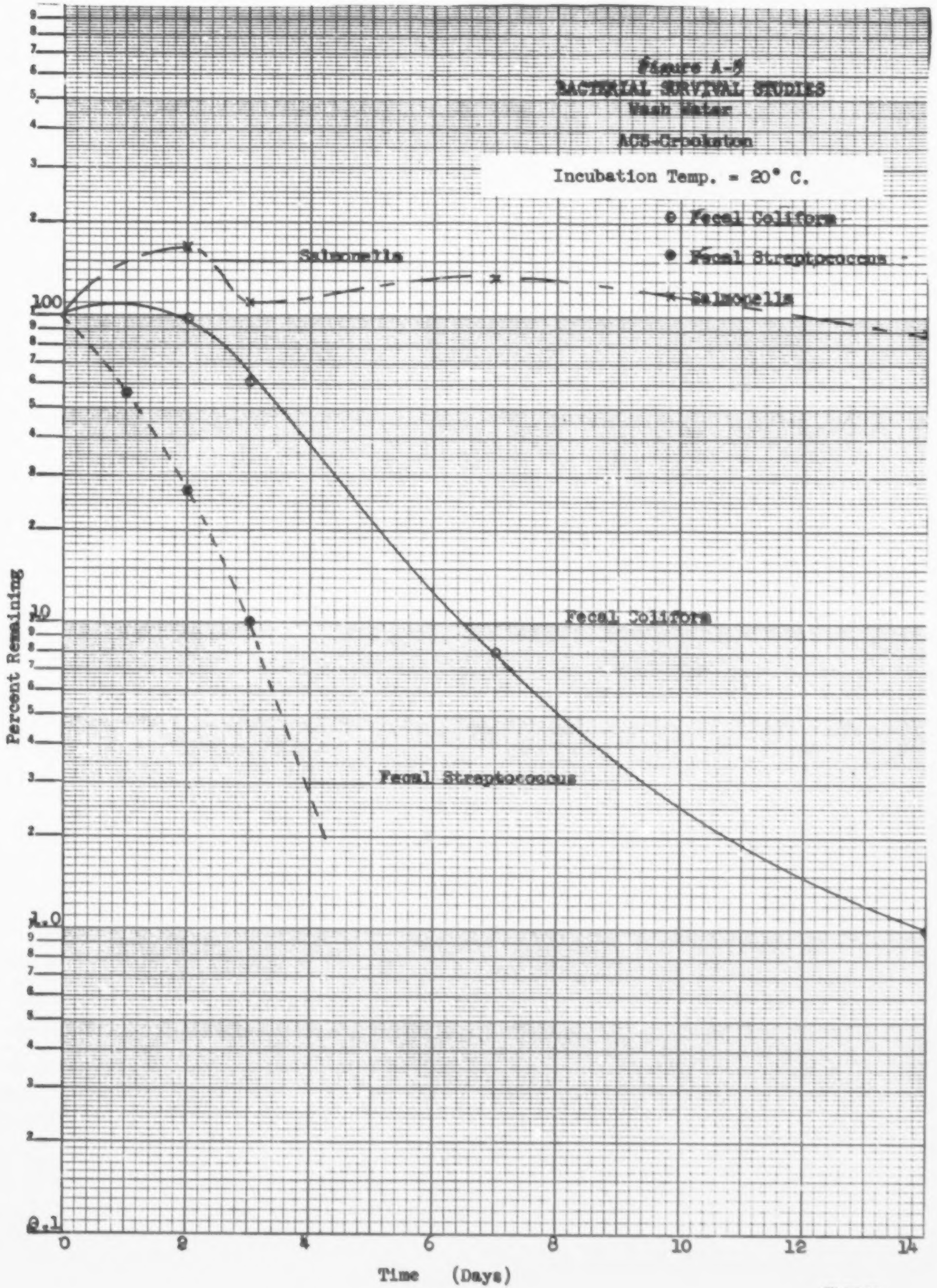


Figure A-5
BACTERIAL SURVIVAL STUDIES
Wash Water
AC5-Crookston

Incubation Temp. = 20° C.

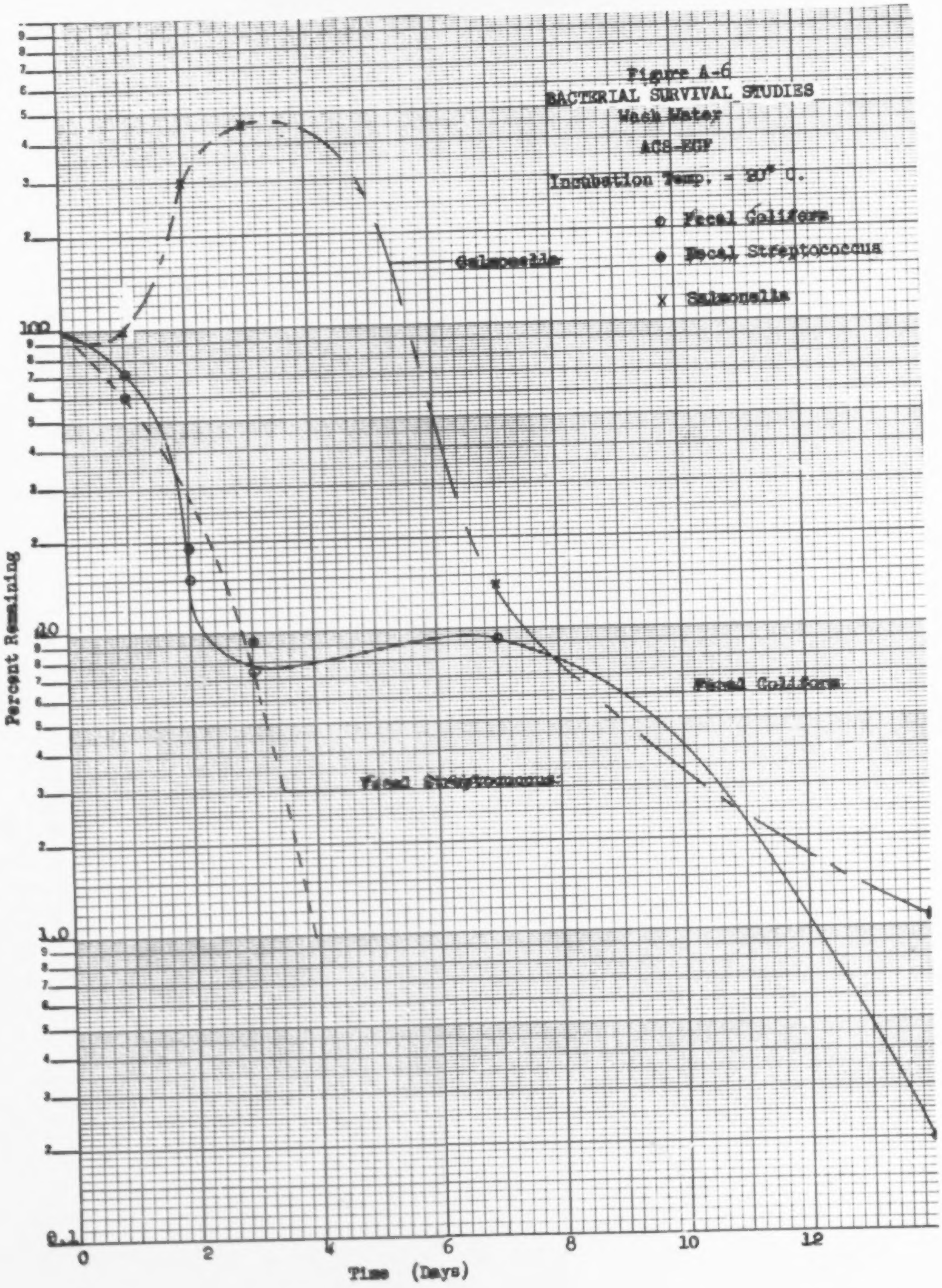


Figure A-6
BACTERIAL SURVIVAL STUDIES
Wash Water
ACS-EGF
Incubation Temp. = 20° C.

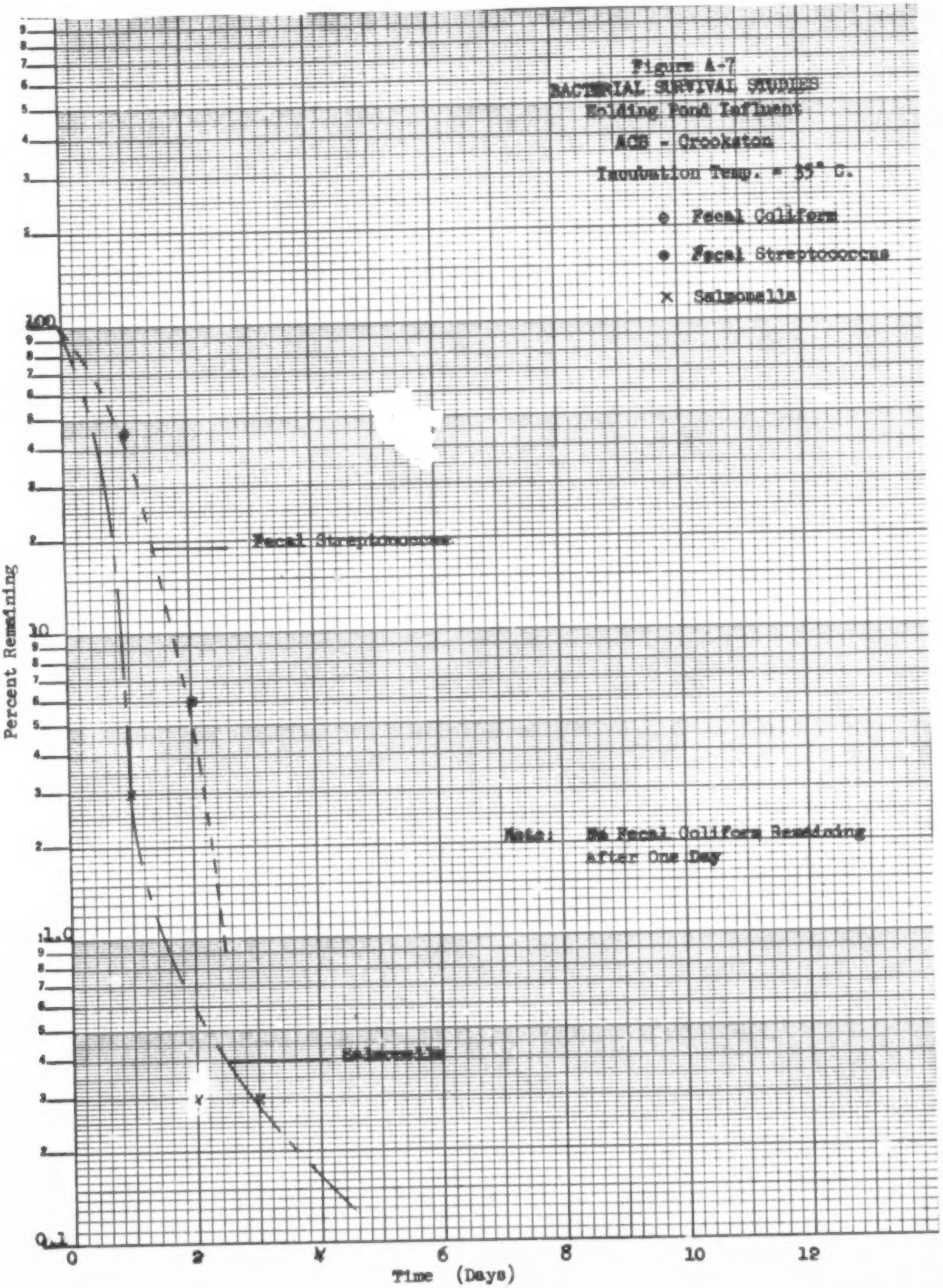


Figure A-7
BACTERIAL SURVIVAL STUDIES
Holding Pond Influent
ACE - Crookston
Incubation Temp. = 35° C.

Note: No Fecal Coliform Remaining after One Day

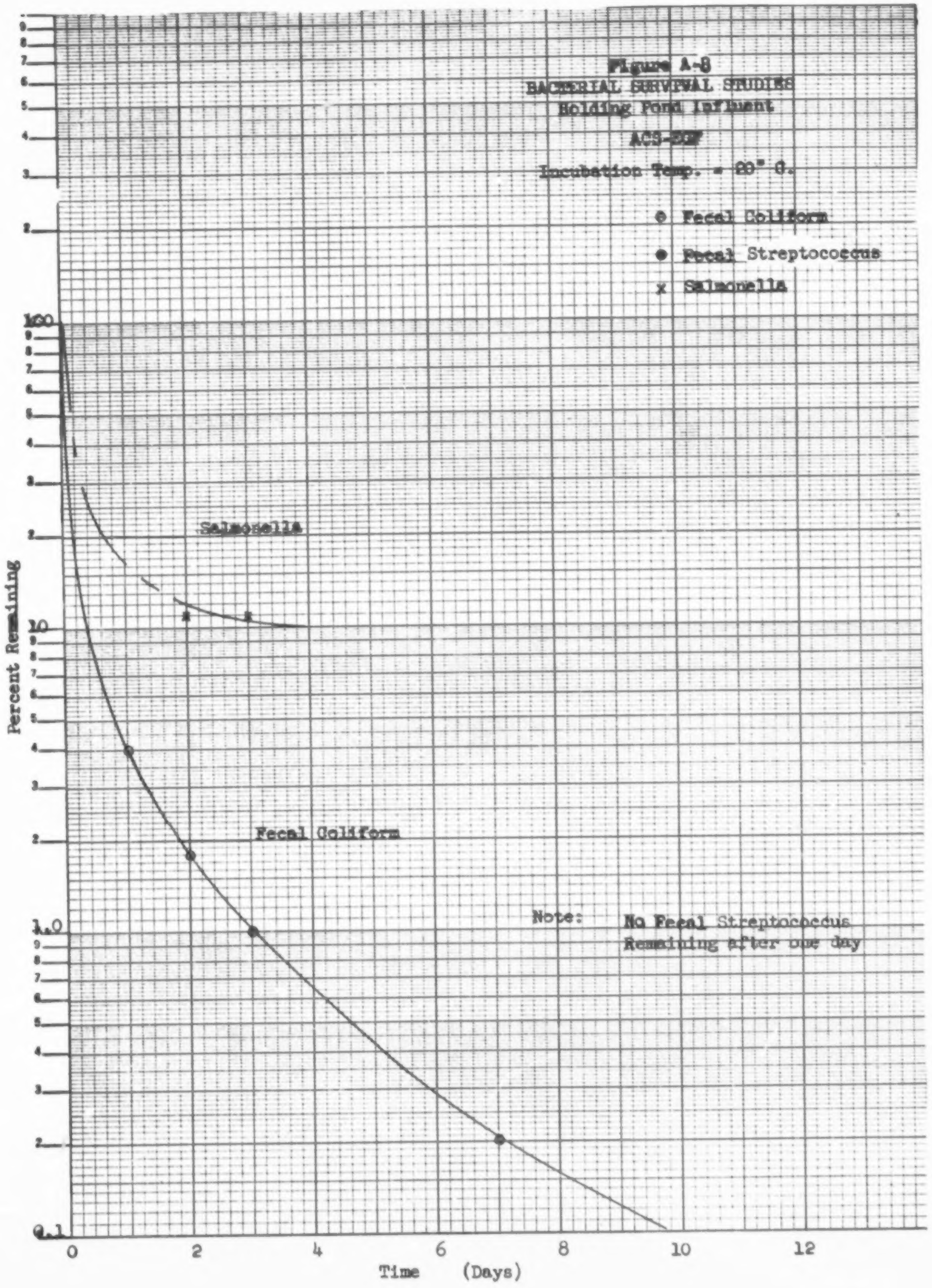


Figure A-8
BACTERIAL SURVIVAL STUDIES
Holding Pond Influent
ACS-SGF
Incubation Temp. = 20° C.

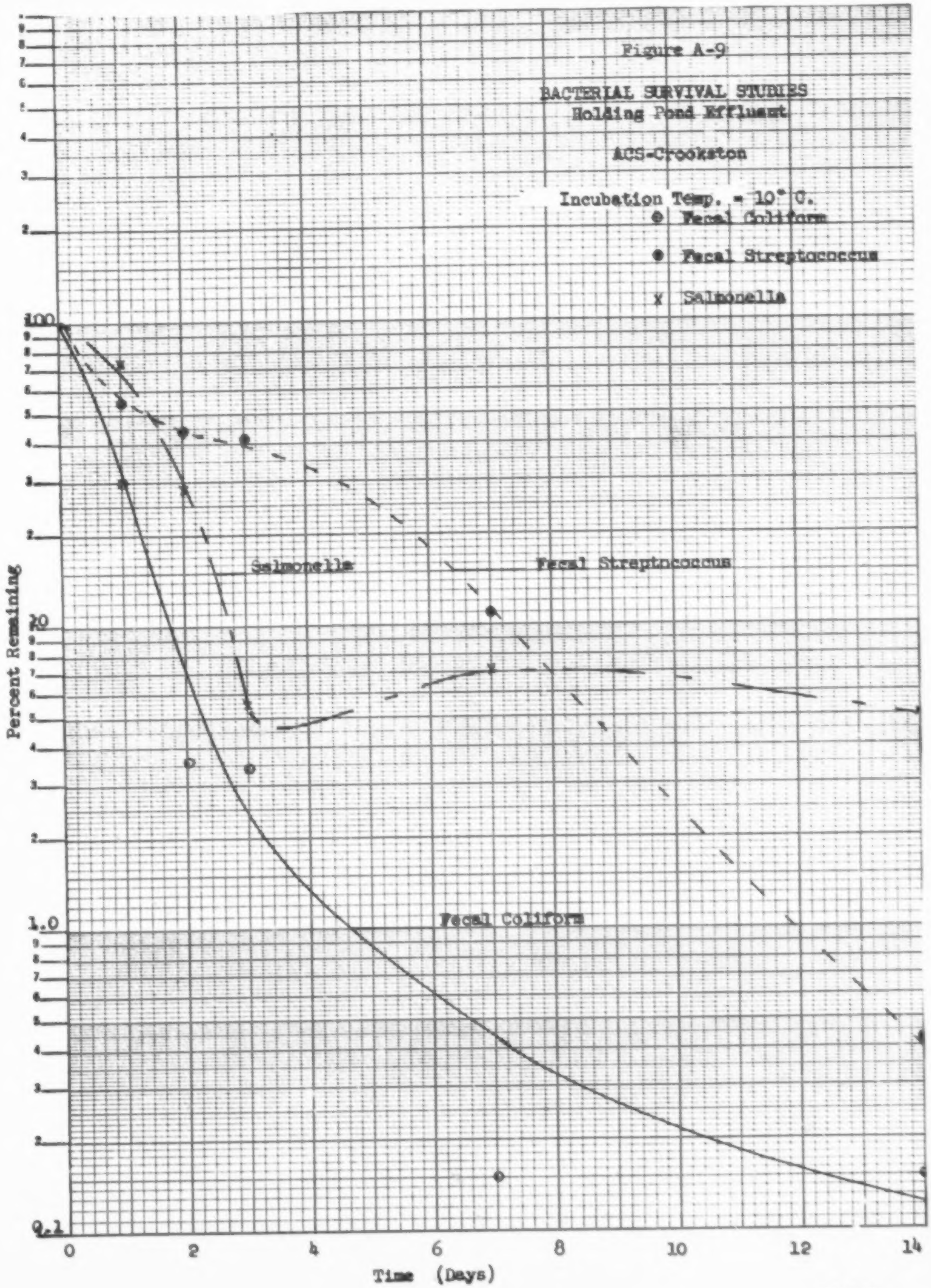


Figure A-9

BACTERIAL SURVIVAL STUDIES
Holding Pond Effluent

ACS-Crookston

Incubation Temp. = 10° C.

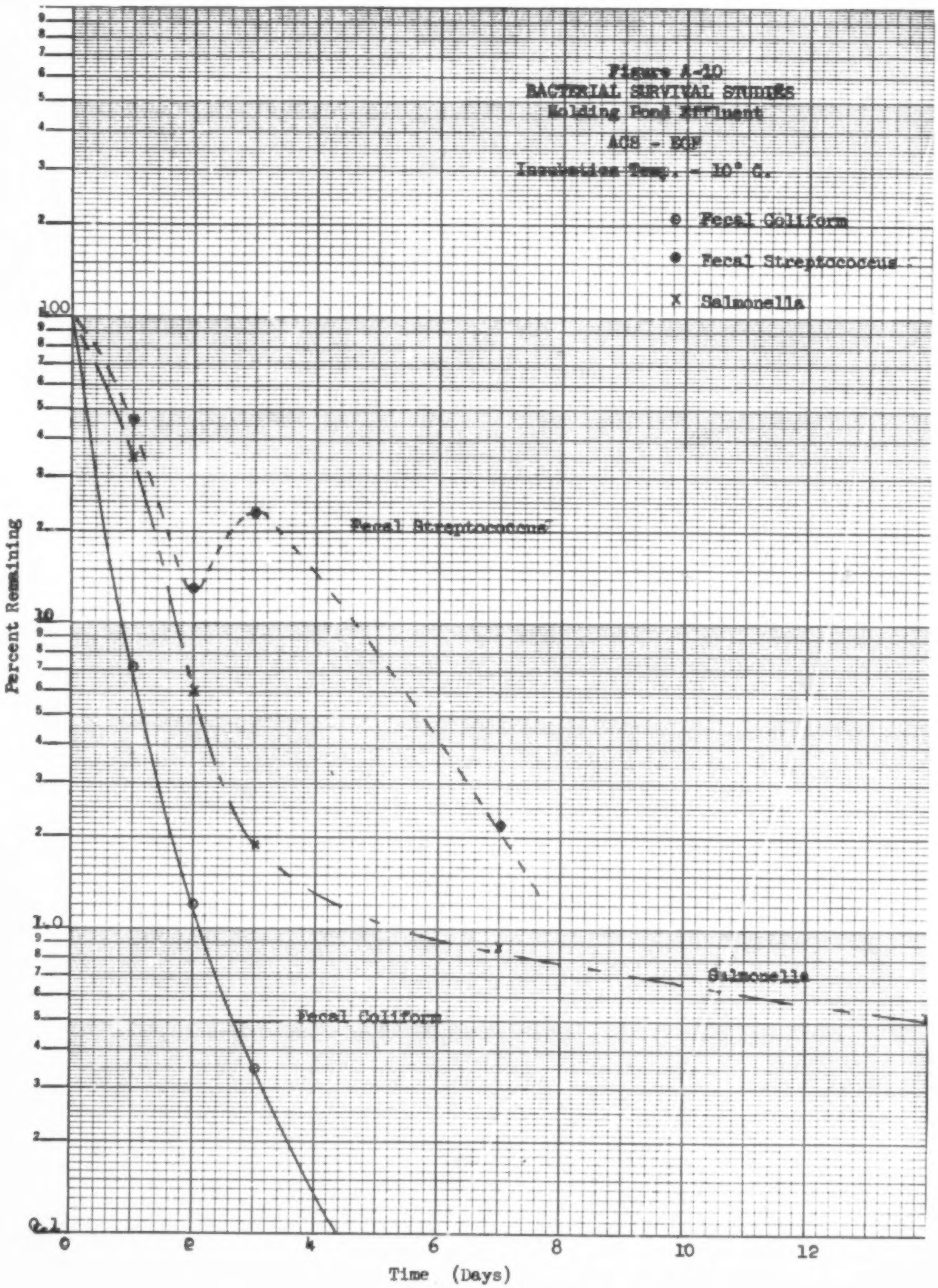


Figure A-10
BACTERIAL SURVIVAL STUDIES
Holding Pond Effluent
ACS - EGF
Incubation Temp. - 10° C.

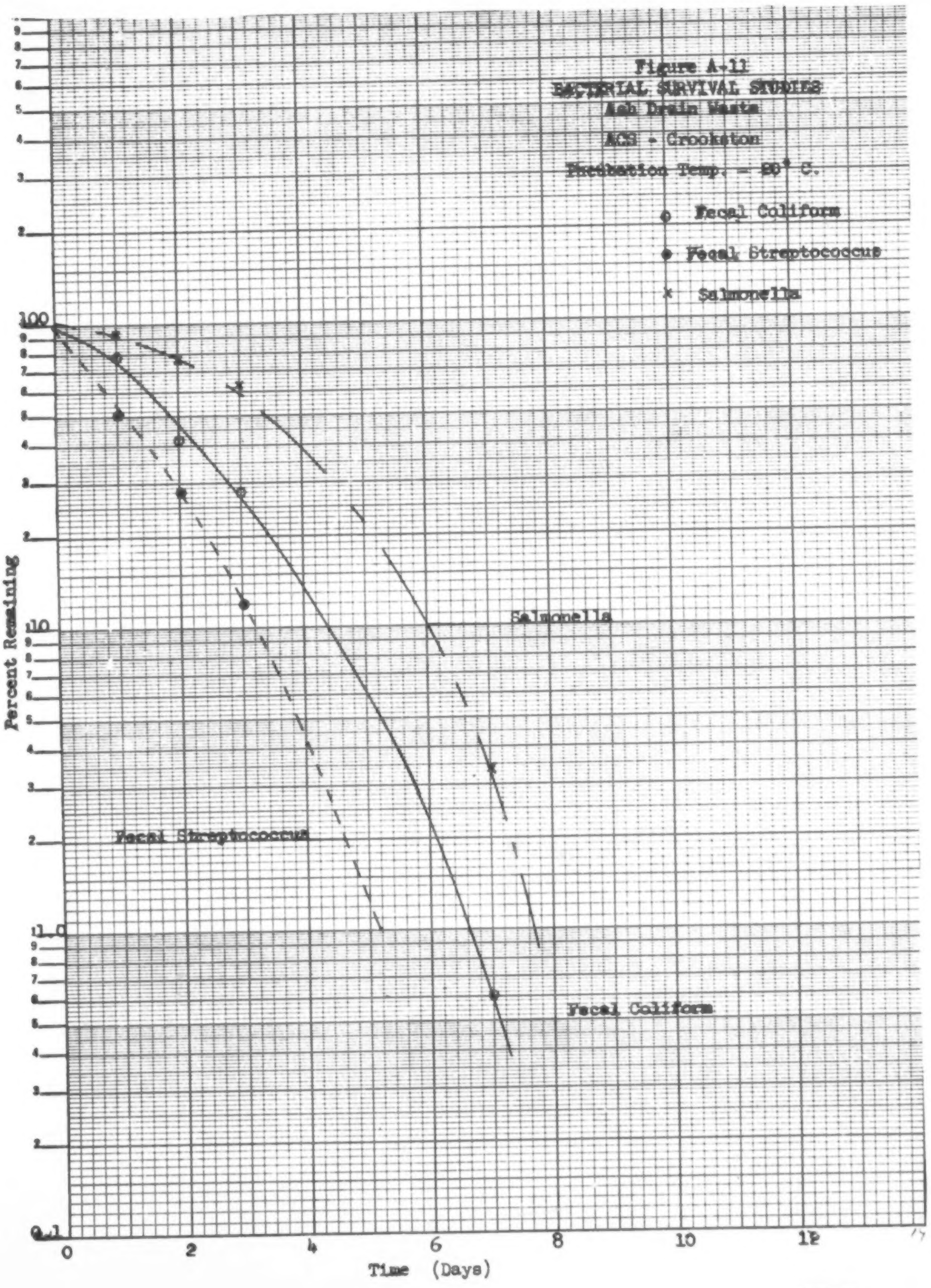


Figure A-11
BACTERIAL SURVIVAL STUDIES
Ash Drain Waste

ACS - Crookston

Incubation Temp. = 20° C.

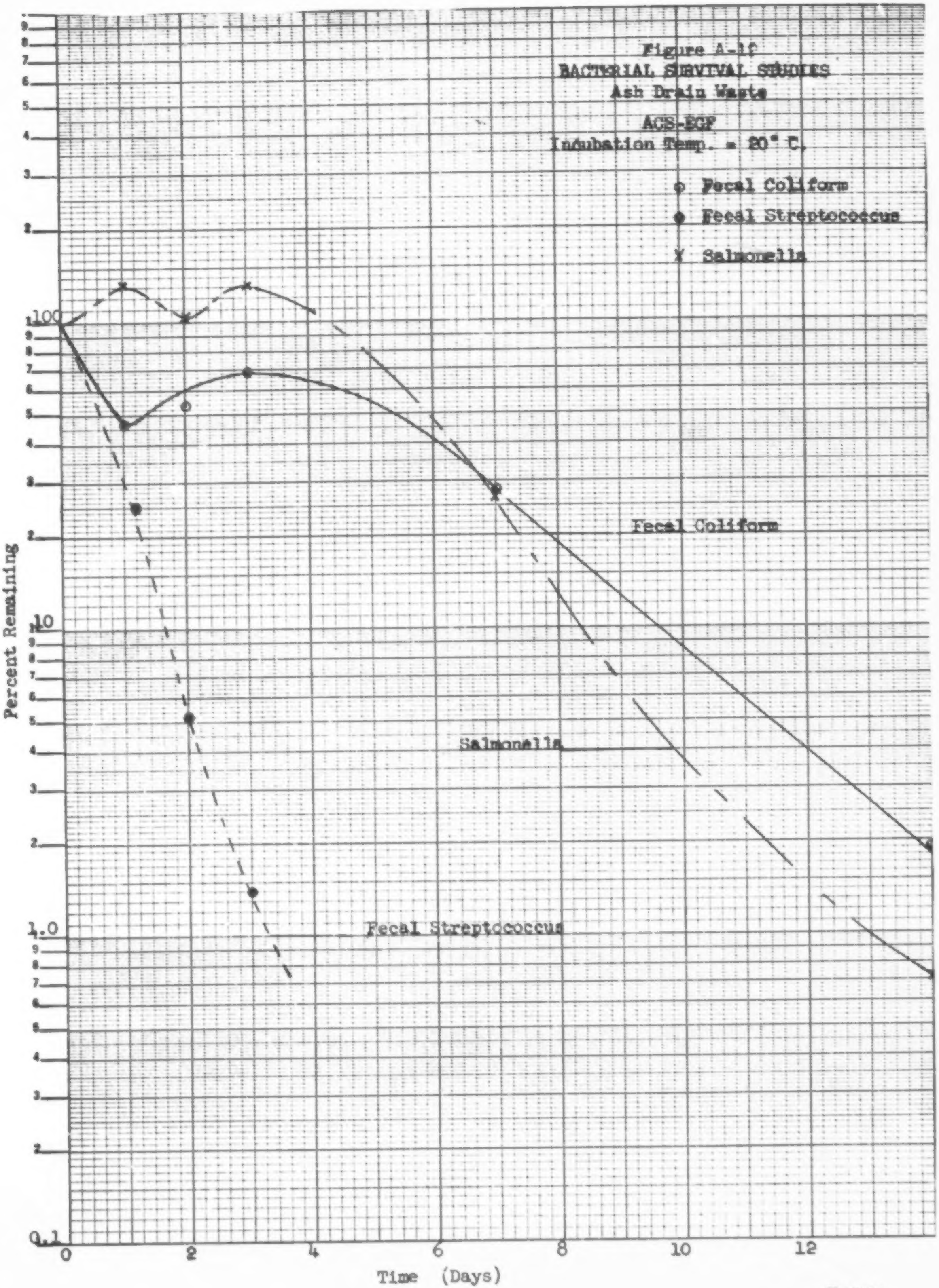


Figure A-1f
BACTERIAL SURVIVAL STUDIES
Ash Drain Waste
ACS-EGF
Incubation Temp. = 20° C.